ELECTRICAL REVIEW

ILLUSTRATED.

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The Telegraph as an Aid in Determining Longitude.

Next week the government will send out the naval steamer "Yantic" on a six months cruise with a scientific party from the hydrographic office, in charge of Lieut. John A. Norris, to determine the longitude of a number of important stations recently connected by the new French cables from Santiago de Cuba, through the island of Hayti and thence to Laguyra, Venezuela. Lieut. Norris has been engaged on longitude work most of the time for the last 15 years and keeps following up the principal extensions of telegraph lines to countries not hitherto reached. The determination of longitude by astronomical observations, without the aid of the telegraph, is difficult and liable to serious error. The government officers go out equipped with telegraph instruments and materials, with which connection is established between the telegraph offices and temporary observatories at which the work is to be carried on. When land lines are used, two circuit-breaking chronometers are placed in circuit, one at each end of the line, and the signals made by them are automatically recorded, side by side, on a chronograph sheet, from which the difference in time can be readily seen. When working on submarine cables the observers watch the mirror signals and make the records by hand. The siphon recorder will do very excellent work, but the difficulty of transporting and setting up this instrument has prevented its general use in longitude expeditions. Several years ago Lieut. Norris established the longitude of a line of stations through India and along the Chinese coast, connecting Madras, India, and Vladivostok, Siberia. Madras had previously been fixed by the English Government by the way of the Red Sea lines, and Vladivostok by the Russians by the Siberian overland lines, and the difference by these two routes from Greenwich to Vladivostok was less than 500 feet. Another instance of correct work, made possible by telegraphic communication, was the determination of the longitude of Cordova, in the Argentine Republic; one set of observations having been carried on over the first Atlantic cable, through the United States and Central America and down the southern coast of South America, and the other through the Atlantic Islands to Brazil and over the country to Cordova—the difference in this case being only 75 feet. The entire work between Greenwich and Cordova by both routes was done by Americans.

"Budstikken."

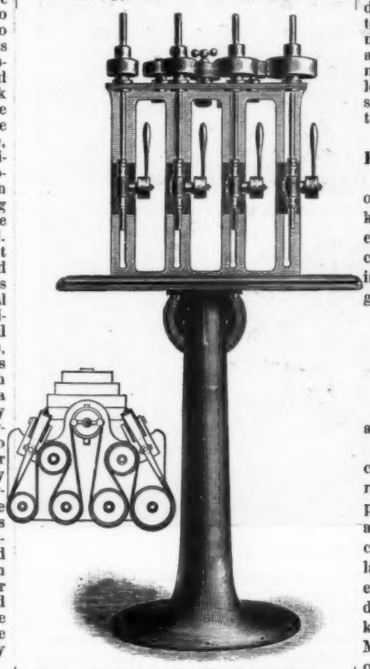
Budstikken is the name of a Scandinavian newspaper; it is an old Norwegian word, 1,200 years old at least.

In those days, when the coasts of Norway were ravished by pirates, the inhabitants had to resort to all sorts of devices to warn those at a distance of the approach of these piratical craft. When one was seen on the horizon a man went up to the top of a mountain, where he lighted a beacon fire. This could be seen for a long distance, and was known to be a warning. When it was seen in the distance another fire was lighted on another hill, until all over the country fires blazed from every hilltop and the people prepared to defend themselves.

They also had a system of messengers. The man who first sighted the sail would take an arrow and send it to his neighbors. From town to town this arrow was sent, until all were warned. These were rather primitive ways of telegraphing, but were so effectual that in the course of 24 hours all Norway knew of the approach of pirates. This system of spreading the news was called "Budstikken," and the word is extensively used as a name for newspapers in the old country.

Improved Sensitive Drill.

The four-spindle drill illustrated on this page is manufactured by the Dwight Slate Company, of Hartford, and is finding its way into numerous electrical factories of the country. It is new in the market, and is rapidly becoming popular where all kinds of light drilling, counter-boring and reaming are required. It is mounted on a substantial column, heavy table with drip groove for oil or soda. The spindles are made of tool steel ¾" inch diameter, 23½ inches



NEW AND IMPROVED SENSITIVE DRILL.

long. They are adjustable on the post to distance of 12¾ inches from top of table to bottom of spindle, and when set have a throw of 3¼ inches by feed-lever. Distance from center to center of spindles, 6 inches; from face of column to center of spindle, five inches. The spindle-driving pulleys are 3¼, 4, 4¾ and 5½ inches in diameter. On the back stud is a 10-inch driving pulley and a three-speed cone. Mr. Slate's work has long occupied a position in the front rank of this class of manufacture, and his improvements are always welcomed.

Electric Lights for China.

A Chinese syndicate for introducing the electric light into the flowery kingdom has been formed in Chinatown, San Francisco, with a capital of $6,000,000, part of which is furnished by white investors. The company expects to receive news very soon of important concessions granted by the Chinese government for putting electric plants in the large cities of China. Meanwhile a small plant will be put up in Chinatown to prove the merits of the system to the celestials.

The Civil Service and Government Electrical Workers.

The Civil Service Commission has two boards of electrical examiners. Applicants for places connected with the running of government electric light plants have to pass the steam and electric examining board, of which Engineer Geo. W. Baird, U. S. N., is the electrical expert. Candidates for such positions are required to be experienced steam engineers, but the board considers that a good dynamo "will run itself," and that a man who understands its construction can soon learn to manage a lighting plant. The telegraphic examining board consists of Thomas Morrison, of the State department, O. D. La Dow, of the agricultural department, and Chas. O. Pierson, of the war department, all old operators. Ambitious telegraphists who desire to serve the government are put through their dots and dashes at the rate of 20 words a minute, and are made to answer a few problems in fitting up local offices, the hardest of which is how to switch a sounder into circuit with either of two relays by means of a two-point switch.

Hourly Record of Electric Light Plants.

Some months ago Superintendent Powell, of the Treasury Department, stated a plan of keeping an hourly record of the operation of each electric lighting plant in the post offices, custom houses and other government buildings throughout the country. These records give the

Steam pressure;
Pounds of coal consumed;
Quantities of oil and waste used on engines;
" " " " " dynamos;
Measure of current in volts;
" " " amperes;
Supplies issued,
and pertinent facts on any point.

Monthly statements show the quantity and cost of all material consumed; the cost of repairs to the plant; the wages of all employés; the average voltage; the total ampere load for the month and the exact cost per watt. Photometric tests of the lamps show how much of the electrical energy developed is turned into light. A detailed descriptive record of each plant is kept in the department, and the data, which Mr. Powell is collecting, will furnish means of comparing the usefulness of the various kinds of engines, dynamos and other portions of the apparatus.

More Subways.

The Board of Aldermen, of New York, have passed a resolution granting the Board of Public Works permission to issue permits or to extend the limit of those already issued for streets or avenues to be opened for subway construction for a continuous distance of not more than 1,500 feet in any one place until December 15. It is expected that work of construction will be pushed at a lively rate until that time.

It is stated that George Westinghouse, Jr., has just concluded the purchase of some valuable copper mines in Washington County, Arizona. His electric company uses several million pounds of copper every year in the manufacture of electrical machinery, and, by having its own mines, the saving in the cost of copper will amount to a considerable sum each year. It is also intended to get beyond reach of the proposed Lake Superior copper syndicate. The mine will give employment to about 300 men.

GENERAL ELECTRICAL ITEMS.

The Western Union Telegraph Company will rebuild its line from Chicago to Sioux City.

The capital stock of the United Edison Manufacturing Company has been increased from $500,000 to $1,000,000.

An electric railway for the conveyance of passengers and goods has been constructed and opened at Buda Pesth, in Hungary.

The Albany (N. Y.) Illuminating Company (Westinghouse) has been awarded the contract for supplying lighting current to the government building in Albany.

An installation of 80 Bernstein series lamps of 50 candle-power each has just been put in by the Wright Engineering Company in the store of W. S. Butler, Tremont street, Boston.

The Savannah Electrical Company, of Savannah, Ga., has taken the agency for phonographs and phonograph-graphophones in that city under the authority of the Georgia Phonograph Company.

The supreme court of Pennsylvania has decided that the city may charge the Western Union Telegraph Company a certain amount per annum for maintaining poles and wires on the public streets.

While the use of electricity in London for illumination, public and private, is steadily and rapidly increasing, the use of gas is increasing quite as rapidly. The gas has been in the greatest demand for stove use and cooking.

The city of Savannah, Ga., has asked for proposals for furnishing the city of Savannah with the entire plant necessary for 300 arc lamps of 1,000 candle power or its equivalent, either wholly or partly of incandescent lights.

It is stated that the Consolidated Street Railway Company, of Omaha, Neb., has purchased the Mercer electric street railway. This gives the organization a monopoly of all cable, electric and steam car lines in the city of Omaha, aggregating 72 miles.

The Fort Wayne Electric Light Company will now operate their works with two sets of men, thereby running 24 hours per day. For the past few months the one force has been compelled to work over-time, sometimes working till 10 o'clock at night and later.

The new government building at Baltimore will be occupied on January 1st, prox., whether the combination fixtures, for which specifications have just been issued, are ready or not. The fixture manufacturer who can do the work in the shortest time will stand the best chance of getting the contract.

A large fire at Decatur, Ala., on the 27th ult., completely destroyed the telephone exchange, and all office books and furniture; a new Western electric standard switchboard has been ordered, a new office secured, and the work of repairing the damage is being rapidly pushed.

Elisha W. Andrews, one of the originators and the first president of the American District Telegraph Company, died at Morris Plains, N. J., Wednesday, 23d ult. He was born in Wallingford, Conn., 70 years ago. Five years ago he was stricken with paralysis, from the effects of which he never fully recovered.

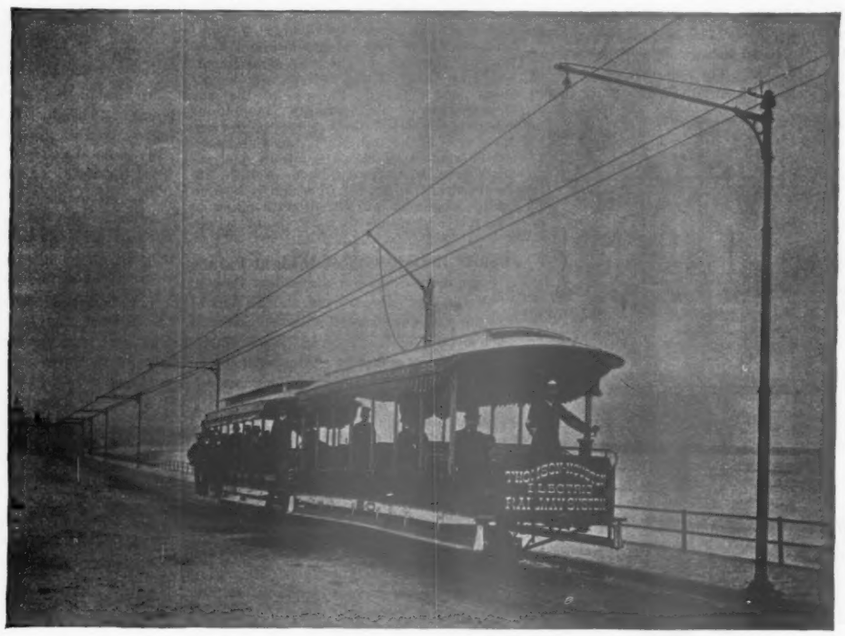
The Decision in the Injunction Cases.

JUDGE ANDREWS SUSTAINS THE ELECTRIC LIGHTING COMPANIES, AND EVIDENTLY BELIEVES IN THEIR VESTED RIGHTS —THE OPINIONS OF INTERESTED PARTIES.

The REVIEW announced in its last issue that Judge Andrews, of the State Supreme Court, had continued the injunctions asked against the Board of Electrical Control, the Mayor and the Department of Public Works. The decision was handed down just as the REVIEW was going to press and we could only announce the fact. Below we publish an abstract of the opinion, covering all the points made. It will be remembered that the suit was brought by the United States and Brush Illuminating Companies to prevent the city from summarily tearing down their lines, and the decision, of course, protects all of the other local companies.

The decision embraces about 15,000 words, and at first recites very fully the history of the case, the law creating and governing the Board of Electrical Control and the evidence presented by both sides. Continuing, the court says:

The defendants claim that after the passage of said act of 1887 no telegraph, telephone, or electric wires could be continued or maintained in this city without permission of said board or its immediate predecessor, the Board of Commissioners of Electrical Subways, and that as the plaintiff has not obtained such permission, the present board has the absolute power to compel the instantaneous removal of all such poles and wires without regard to whether such wires are or are not unsafe; that if it has not such power it has power to regulate the use of wires, and under such power of regulation had the right to adopt said resolution, and that after the adoption of such resolution the Commissioner of Public Works had the right to remove such wires as the expert of the board declared were unsafe, upon the ground that such wires were unlawful obstructions of the streets.



VIEW OF THE ELECTRIC RAILWAY AT NEWPORT, R. I.

The plaintiff contends that said acts of the Legislature do not give or purport to give any such absolute power to said board, and that if said acts did, in terms, give such power, they would be unconstitutional; also, that assuming that said board has power to regulate the use of wires, it has no right to compel the companies to turn off the electric current from unsafe wires, nor has the Commissioner of Public Works any right to remove wires which said expert may pronounce unsafe.

It does not admit of dispute upon the papers before me that some of plaintiff's wires are imperfectly insulated, and are dangerous to life, and that the due protection of the public imperatively demands that such wires should be removed or made safe without delay.

On the other hand, the plaintiff has vast property interests at stake, and claims that it always has been and is now ready and willing to make its wires safe, if permitted to do so, and it strenuously insists that it is the plain duty of the court to continue such temporary injunction.

When the act of 1884 was passed, the plaintiff's poles and wires had been placed in the streets of this city under and by virtue of the authority of the Legislature and of the Common Council, and it had expended large sums of money in so placing the same. It also then had undoubted authority, under previous laws, to place its wires underground, but unfortunately, the act of 1884 was so framed that it was claimed to be impracticable for the plaintiff and other similar companies to comply with its provisions. The acts of 1885 and 1887 deprive the plaintiff and other companies therein mentioned of the power to put their wires underground without permission of the present Board of Electric Control or its predecessor, and such permission has never been given.

Since the contract was made on July 27, 1886, by the Board of Commissioners of Electrical Subways with the Consolidated Telegraph and Electrical Subway Company for the construction of subways, that corporation has continuously had, and now has, the sole and exclusive right to construct such subways. Since 1885, it has not been, and is not now, in the power of the plaintiff or other similar companies to place their wires underground except in subways constructed by said Consolidated Subway Company.

The total amount of subways constructed up to the present time is only about 11 miles, and those are built in a few streets only, and the plaintiff and other similar companies have hundreds of miles of overhead wires in streets where there are no subways whatever. It does not appear that the plaintiff or other electric light and power companies have any control over said consolidated Subway Company, which has the exclusive right to construct subways. It is claimed on behalf of the defendants that, after the passage of the act of 1887, all telegraph, telephone and electric companies continued and maintained their poles and wires by the mere sufferance of the Board of Electrical Control, and that said board, by refusing its permission for such continuance or maintenance, can without notice, and, without making any compensation, compel all said companies to forthwith remove all their poles and wires; and it necessarily follows that if said board has such power, it has the absolute right to destroy property of the value of many millions of dollars, invested under the express authority of the Legislature; to wholly deprive the inhabitants of this city of all means of communication by telegraph or telephone, and to deprive such inhabitants and the city itself of the use of all electrical currents for the purposes of illuminating and furnishing power.

It is impossible to sustain this claim as to the power of said board, for it is inconceivable that the Legislature should have intended to invest any board, however well constituted, with such vast and unrestrained powers.

Judge Andrews decides that the electric light company has the right to maintain its wires overhead until the subways for their accommodation are completed, and fixes the responsibility for the failure to complete the subways on the Subway Company, but says that the duty of keeping its wires properly insulated devolves on the plaintiff, and that permission to repair old wires and replace them with new and safe wires should be obtained from the Board of Electrical Control by mandamus if refused. The decision ends as follows.

My conclusion upon the whole matter is this: The Legislature authorized the plaintiff and similar companies to erect poles in the streets and string wires thereon to be used for furnishing light and power; it subsequently adopted laws with the view to having such wires placed underground in conduits and subways. For some reason but few of these conduits and subways are ready, and the plaintiff and other similar companies cannot put their wires underground. Pending the construction of such subways, they have the right to maintain their overhead wires. Some of these wires are undoubtedly dangerous to life and ought to be repaired or removed. The Board of Electrical Control has the right to require the plaintiff and similar companies to discontinue the use of such dangerous wires, but has not the power to compel the plaintiff and other companies to remove the same; the Commissioner of Public Works cannot remove the same without notice to the plaintiff and without giving it an opportunity to put its wires in safe condition, but can do so after giving such notice and a reasonable opportunity to make repairs; the company should have such reasonable opportunities to put its wires in safe condition, and if it does not do so, the same should be removed by the Commissioner of Public Works as obstructions, or the matter should be laid before the grand jury of the county; in the meantime the injunction heretofore granted, with some modification of its general restrictions, should be continued until the trial of the action.

If the view taken by me in this matter is erroneous in any respect, a speedy review of my decision can be obtained by bringing the case on for trial at the Special Term to be held in November or by an appeal to the General Term from the order continuing the injunction, and I make it a condition of the granting of such order that the plaintiff stipulate to take short notice of trial for the November term, and to try the case at the first opportunity, and also stipulate to argue the appeal from such order, if one shall be taken to the General Term, at the term which shall commence on the second Monday of November. The order will be settled on notice.

HOW THE OPINION IS REGARDED.

President C. H. Jackson, of the United States Illuminating Company, is very naturally well pleased with the decision, and said it afforded an opportunity which he had been anxious to have for a long time to entirely overhaul and repair the company's overhead lines in this city and replace with new wire of the best insulation every foot of underwriters' wire on its system.

"Both the United States and the Brush Company have, since the original injunction was granted," said he, "been busily engaged with an extra force of men in putting up all the new wire which the factories of the country could supply, and have already removed over half of their underwriters' wire, and substituted wire of the very highest quality of insulation in its place, regardless of expense. Both companies plan to use their new circuits, which they know to be safe, but will not use any of their old circuits until they, too, have been replaced by new wire of the highest insulation. The Brush and the United States Company are spending over $100,000 in the interest of public safety in putting up an expensive system of new wires, which they expect will have to be taken down within the next two years and subways provided for them."

Paul D. Cravath, the lawyer who directly represents the United States Company, and has really had general charge of the interests of all, said: "The decision fully sustains the position which the companies felt it their duty to take, and at the same time affords ample protection to the public. It ought also to be satisfactory to the Board of Electrical Control, as the Judge's opinion gives a clear statement of the authority of the board over overhead wires, which has been needed for a long time."

Electrical Expert Wheeler declared to a reporter that under the decision all that he could do now was to hunt for defective wires and then certify to the companies that such wires were defective. "We have already found about 5,000 such cases," he said, "and they will be at once reported to the companies. There are very few circuits in the city on which such defectively insulated wire cannot be found, and if they run currents only over the perfect ones, then lighting operations will be exceedingly limited in their scope."

William H. Browne, manager of the United States Company, said: "We feel that the decision of Judge Andrews will harmonize the relations between the companies and the board. For many months back we have been so hampered in our business by their restrictions that we have not been able to make the repairs which in justice to our customers and the public we desired to make."

Mr. Chas. W. Spear, of the Brush Company, explained the situation by the story of Pat and his Irish bees. "In recounting the wonders of Ireland he declared that the honey bees there were as big as sheep. A little later some one asked him casually how big the hives were in Ireland, and he admitted that they were about the size of those he saw here. 'Then how could they get into such small hives,' Pat was asked; and his complacent answer was, 'Sure, that's their own lookout.' The Board's subways have been like the hive, and it has been our lookout how we were going to get into them. We have been willing and anxious to put our cables underground ever since the beginning of this agitation. The construction of the subways has been extremely slow. The chief difficulty, however, has arisen from the conflicting and impracticable rules of the board, which absolutely prevented us from keeping our lines in a good condition of repair, and as a matter of fact the board itself should be held responsible for every accident which has happened through a faulty wire. From the standpoint of mere corporate interest we could not afford to have our lines imperfect. An electric light plant, like every other kind of business, is run with the idea of making a profit. If our wires are defective our currents are wasted and we suffer loss. Our linemen were repeatedly arrested while at work, or when attempting to go to work repairing wires, and the Board would not permit us to string a new wire under any circumstances. We hope that a better understanding may now be arrived at, and shall certainly do everything in our power to further the interests and safety of the public."

The Newport Electric Railway.

The Newport street railway, operating the Thomson-Houston electric railway system, is illustrated in the accompanying cut. The construction of this road, it will be remembered, was bitterly opposed by the summer residents, but without avail, as from the time it was commenced until it was finally completed, the work was not interrupted in any way. The trial trips were made on August 2d, when the run to the beach, a distance of two miles, was made in about five minutes with a load of 70 passengers.

The road was regularly put in operation August 7th, since which time four cars, each equipped with two 15 horse-power motors, have been in daily use, making 209 round trips, covering 522 miles, and carrying on an average about 10,000 passengers per day. The road is 4.5 miles in length, and is laid with 40-pound T-rail. The cross suspension method is mainly used, though in several places the proximity of the track to the sidewalks has necessitated the employment of the single bracket method. Although the maximum gradient is eight per cent., there is not the slightest difficulty in operating the cars upon it, even when they are heavily loaded with passengers.

The current necessary for the propulsion of the cars is obtained from the local electric lighting company.

The operation of the cars has been perfectly satisfactory in every way, and the increase in the number of passengers has been far greater than the anticipation of those interested in the road. It sprang at once into popular favor, and from all indications will maintain itself there indefinitely.

Fire in an Electric Motor Factory.

A fire broke out in the factory of the Elektron Motor Company, corner Jay and Plymouth streets, Brooklyn, Thursday morning of last week, and greatly damaged the building, destroying a large amount of stock, but fortunately but slightly damaging the machinery and electrical apparatus. The fire caught in the roof from some unknown cause, and the roof and upper floor were burned away.

The business of the company will receive but a slight check on account of the fire, and they will be able to commence filling orders again inside of another week. A much larger factory has been secured, and more ample facilities will hereafter enable the Elektron Company to more rapidly handle the growing business.

Comment of the Daily Press on Judge Andrews' Decision.

THE BOARD OF CONTROL RESPONSIBLE.

For this muddle, involving the safety of the community, the Board of Electrical Control is to be held responsible. Had the members of that board done their duty to the public, the subways would have been done and the wires buried in them long ago. The only way out of the difficulty now is to put these delinquents aside and call to the post men who will serve the people instead of themselves.—*N. Y. Herald.*

A CHANGE OF POLICY ASKED.

Justice Andrews' decision puts the blame for the dangerous condition of many of the electric light wires on the Board of Electrical Control; first, because the subways which should have been provided have not been made ready, and the companies have consequently been unable to place their wires underground; and, secondly, because the board has not permitted the companies to replace badly insulated and dangerous wires with good and safe conductors. At the same time he makes it plain that the board has the right to compel the companies to discontinue the use of dangerous wires, but the removal of such wires can only be accomplished by the Commissioner of Public Works after due notice to the companies and their refusal to make them safe. It has long been apparent that this board was making the slowest progress in the work it was constituted to perform. Mayor Hewitt lost all patience with its method of doing work—or not doing it—and Mayor Grant has almost reached the same point. Only the other day, when Mr. Grant sought to give the illuminating companies the right to build their own subways, the other members of the board stoutly set their faces against the proposal. Clearly it is time for a change of policy. The subways are a necessity, and must be provided without delay.—*N. Y. Tribune.*

GOES FOR THE JUDGE.

The decision of Judge Andrews yesterday continuing the injunction in behalf of the electric light companies virtually ties the hands of Mayor Grant and postpones indefinitely the burial of the dangerous, death-dealing wires. Under it the companies are permitted to go on repairing and stringing their wires. Subways may be built without end and the companies will continue to ignore them. Subways now ready for occupancy throughout the city are treated with disdain by the electric light companies. They have no intention of going underground. The fact that they are spending thousands of dollars in setting up new overhead wires attests this. The decision of Andrews is an outrageous one in every sense, but it is precisely what was to be expected of a Judge who has more than once shown a warm side for corporations.—*N. Y. World.*

"ILL-NATURED PARAGRAPHING."

An injunction is a proceeding on the equity side of the bench. The complainant who asks equity must do equity. We are sure that Judge Andrews will apply this rule as well as all other applicable rules. The ill-natured paragraphing of a morning contemporary, which insinuates that the Judge is at the service of corporations, has no foundation in the present proceedings or in any other that we are aware of, but must be considered a gross perversion of the liberty of the press, and an outrage on the decencies of life.—*Evening Post.*

The New Okonite Factory.

The new mill which the Okonite Company is now completing in Dundee, is one of the largest in town and a marvel of modern architecture and equipment. The delicate but substantially made machines are now being put in place and the sound of the innumerable hammers fall upon the ears of the visitor with a deafening din. One of the most striking peculiarities of the place, however, is the ample provisions made for light. There are in all 270 enormous windows along the sides and ends of the building. Each window contains 12 large panes of frosted glass, making the entire number 6,480. Surely this will serve as sufficient means for the workmen to see. The mill will also have the first supply of water from the canal, yet such an enormous concern cannot depend on one, an uncertain source for power, but is having several large boilers placed in the engine room.—*Passaic, N. J., News.*

Government Telegraph Rates.

POSTMASTER-GENERAL WANAMAKER FIXES THE PRICE TO BE PAID DURING THE YEAR.

The following general order was promulgated at the Post Office Department Thursday, October 31st:

Pursuant to the authority vested in the Postmaster-General by the act of Congress entitled "An Act to Aid in the Construction of Telegraph Lines, and to Secure to the Government the Use of the Same for Postal, Military and Other Purposes," approved July 24, 1866, and by the Revised Statutes of the United States, title lxv., I hereby fix the rates at which such communications as the said statutes prescribe (not including those passing over circuits established by the Chief Signal Officer of the Army) shall be sent during the fiscal year beginning July 1, 1889, and terminating on June 30, 1890, by the several companies within the effect of said statutes, as follows:

For day messages containing not more than 10 words, exclusive of place from, date, address, and signature, 10 cents for all distances not exceeding 400 miles, and one-half cent for each word in excess of 10 words; all distances being arbitrarily determined by the method hereinafter stated.

For distances so determined exceeding 400 miles and not exceeding 1,000 miles, 15 cents for the first 10 words, counted as above provided, and three-fourths of one cent for each word in excess of 10 words.

For all distances exceeding 1,000 miles there shall be added to the price of the message fixed for distances over 400 and under 1,000 miles the sum of one-half cent for each word counted as above provided.

In cases where the price of a message determined as herein provided shall include a fraction of a cent, such fraction, if less than one-half, is to be disregarded; if more than one-half, it is to be counted as one cent.

For night messages of not exceeding 20 words, exclusive of place from, date, address and signature, 15 cents for all distances, and one-half cent for each additional word.

Instead of computing the actual distances of transmission, the distance for payment shall in all cases be taken absolutely to be the number of miles between the capital of the State or Territory, or from the city of Washington, if from within the District of Columbia, from within which (whatever the place) the message is sent, and the capital of the State or Territory; or the city of Washington, if within the District of Columbia, within which (whatever the place) the message is received, as shown in the accompanying table, wherein such distances are given as computed upon the shortest practicable route between such capitals, and which is to be taken as part of this order. Provided: That if the message be sent and received within the same State, Territory, or said District of Columbia, the distance for payment shall be taken absolutely to be the minimum distance of 400 miles.

But it is provided that, if at any time during the year ending June 30, 1890, any such company shall charge the public for a message of 10 body words a less rate than is herein fixed for a like number of body words, the rates herein prescribed shall, as to such company, thenceforth during the year, be reduced to the rates so charged to the public.

The rate for all messages in cipher, known as the signal service weather report, is hereby fixed at not exceeding 2½ cents for each word sent over each circuit as now or hereafter established by the chief signal officer of the army, all messages sent over a circuit being dropped at all designated offices therein without additional charge.

The statutes provide that telegrams between the several departments of the Government and their officers and agents, in their transmission over the lines of any such company, shall have priority over all other business. All officers of the United States sending such telegrams should endorse thereon the words "Official business," and should report to the Postmaster-General any failure to transmit them in such priority, and any charge made in excess of the rates above prescribed.

Each company will be allowed to charge for messages received from another line at the same rate as if received from the Government direct at the point of transfer for transmission over its own line.

JOHN WANAMAKER, *Postmaster-General.*

China Wants More Light.

A large electric light plant is to be put in at Pekin, China, the Westinghouse Electric Company, of Pittsburgh, having just completed the arrangements with representatives of that city. The entire plant was shipped last week and will be installed immediately upon its arrival. The incandescent light is to be used and the number is several thousand.

The securing of this contract is a feather in the cap of not only the Westinghouse Company, but of our country as well, for the competition on the part of European manufacturers was very lively.

Vice-President Byllesby, of the Westinghouse Company, who is now in Europe, will probably run over to China and undertake the somewhat difficult task of translating the language of the electrician into the language of the Mongolians. There are some of these expressions that are as Chinese to the average individual of the country, and gentlemen of the cue may not find it so difficult to comprehend as one would immagine.

ELECTRIC MOTOR IN FACTORY WORK.

Electric Motor in Overall Factory.

The accompanying illustration was made from a photograph taken at the factory of the New England Overall Company, Salem, Mass.

The motor, which is of 1½ horse-power, is of Thomson-Houston manufacture. It is employed to supply power for the large machine shown in the cut, and other machines in various parts of the factory.

Camden, N. J.—The Chemical Electric Light and Motive Power Company. The incorporators are Thomas E. Vandyke, Michael Koch, Marion Mayne, William Williams, John R. McLoughlin and Arthur H. Woodward, all of Philadelphia, and Joseph R. Taylor, of Camden. The capital stock is $50,000, with $10,000 paid in. The objects of the corporation are the purchase, manufacture and sale of every description of appliances for electric lights and motive power.

Harrisburg, Pa.—The following charter was granted the Electric Street Railway Company, of Beaver Falls. The capital is $50,000.

St. Johns, Mich.—The St. Johns Electric Light, Heat and Power Company has been organized at St. Johns. Capital, $25,000.

Carlinville, Ill.—The Carlinville Telephone Company, at Carlinville; to maintain a telephone service; capital stock, $25,000; incorporators, A. L. Given, B. M. Bates and F. L. Bates.

Harrisburg, Pa.—A charter was granted to the Huntingdon Electric Light Company, of Huntingdon; capital, $12,000; the directors are J. Simpson Africa, John G. Simpson and Walter G. Africa.

Belleville, Ill.—The electric light and coal company, at Belleville, to supply coal and furnish electric light and power; capital stock, $70,000; incorporators, John Brosius, G. W. Knobeloch and John E. Thomas.

Des Moines, Ia.—The Council Bluffs Gas and Electric Light Company have filed articles of incorporation with the Secretary of State; the capital is $500,000. Walter S. Wright is president; Charles L. Platt, secretary and treasurer.

Salt Lake City.—A company composed of T. K. Stevens, Murray Godbe and A. A. Moulton, have succeeded the United Electric Company in this city. The new company intend to engage in business on an extensive scale, and have already ordered an electric plating plant.

Seattle, W. T.—The Green Lake Electric Railway Company, of Seattle; capital, $150,000; trustees, E. C. Kilbourne, V. Hugo Smith, C. P. Stone, O. J. Carr, D. T. Denny, L. H. Griffith, James Leddy and William D. Wood. Object, to build and operate street railways in Seattle and elsewhere in King County.

Clarion, Pa.—Governor Beaver granted a charter to the Clarion Electric Company. The incorporators are S. K. Clarke, W. A. Hindman, A. C. McComb, Sloan McComb and A. L. Ivory. The purpose of the company is the supplying of light, heat and power by means of electricity, to the public in this place and vicinity.

New Cumberland, W. Va.—A certificate of incorporation has been issued to the New Cumberland Light, Heat and Power Company, for the purpose of supplying light, heat and power by electricity. The principal office shall be at New Cumberland, and the charter is to expire on October 16, 1939. The sum of $500 has been subscribed to the capital stock, 10 per cent. of which has been paid in, with the privilege of increasing the same to $50,000 in all. The capital is divided into shares of $100 each, which are held by Albert Haigh, R. E. Lindsay, G. W. Stewart, John Porter and H. McMahn, all of whom are residents of New Cumberland.

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We invite correspondence from Electricians, Inventors, and the Telegraph and Telephone fraternity and those engaged in Electric Lighting, on matters pertaining to electrical and scientific subjects, and all facts of special interest in connection therewith.

We extend to manufacturers of electrical apparatus an invitation to send to this office any and all facts concerning their business which will be of interest to the public. We make no charge for publishing news.

Subscribers can at any time have the mailing address of their paper changed by sending both old and new address.

NEW YORK, NOV. 9, 1889.

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It is unfortunate for this city that the World's Fair guarantee fund of $5,000,000 is so slow in being subscribed. The rich New Yorkers don't appreciate, it is evident, what a great thing this will be for the city and country. The electrical industry, though having so far been completely ignored by the committee makers, will be found doing its share at the proper time. But the men who have made their millions in this city should subscribe to this guarantee fund liberally and promptly.

The work of the New England Electric Exchange in the examination of applicants for its licenses, was carried on vigously last month with results that are bound to tell. On one examination day alone 18 applicants were examined.

The latest encroachment of woman upon man's domain is reported from Maine, where the work of soliciting stock subscriptions for a telephone and telegraph company has been undertaken by a member of the fair sex. And what is more, the lady in question has been making a success of it.

Our entertaining sun-down contemporary, the *Evening Sun*, in a column editorial, answers our request for comparative figures in relation to deaths by gas and by electricity in about the manner the old lady kept tavern. (Our readers are probably aware that the old lady never kept a tavern.)

There is much interest in the storage battery suits in view of recent court decisions. It is to be remembered that there is pending a decision in the case of Chas. F. Brush against the Julien Company, on the patent granted Mr. Brush, March 2, 1886, which may change, and will no doubt simplify the present situation.

The attendance at the Paris Exposition during the month of September was very great, and indeed the attendance from the first has been a surprise to the managers. The first two weeks in September showed a total attendance of 2,234,628. The grand total, since the opening to September 15th, was 19,331,580. These are points that the World's Fair committee should consider as giving an idea of what may be expected in this country in 1892.

The term of office of the Brooklyn Board of Commissioners of Electrical Subways expired by limitation November 1st. This board was composed of Messrs. Plympton, Raymond and Reynolds, and they deserve credit for the intelligent and careful manner in which they have proceeded, although they haven't accomplished the wonders that an uninformed public and press expected. From the beginning these gentlemen had the confidence of the electrical people and worked in nearly every instance in harmony with them, and as a result have the wire situation greatly improved, with a large number buried and otherwise so disposed as to cause scarcely any annoyance or danger. It is very different with the New York Board.

The Secretary of the Treasury will make a recommendation in his annual report to Congress, that the law requiring the lighting of bridges over navigable waters according to the regulations of the Lighthouse Board be amended, by the addition of a penalty for disregard of the rule. The authorities of the Brooklyn bridge have refused to obey the orders of the department, and this amendment of the law is expected to bring them to terms. The bridge is a thing of beauty and a joy forever, but its brilliant electric illumination is said to be a bewildering danger to navigators. The rule of the Lighthouse Board requires that single-span suspension bridges shall have the middle of the channel passage marked by two green lights, and each margin of the channel by two red lights.

Amos J. Cummings, ex-president of the Press Club, ex-editor of the *Sun*, ex-Congressman, soon to be Congressman-elect, but not ex-good, true fellow, was given a dinner by his fellow members of the Press Club Thursday evening of last week. There were many kind words said about Mr. Cummings on this occasion and he deserved them all, and his friends know that compliments will not spoil him. Mr. Cummings is one of the best newspaper men we have knowledge of. His articles were always full of meat, full of ideas, and he had the faculty of making the most hackneyed subjects interesting and suggestive. The milk of human kindness is his, also. The REVIEW predicts that Mr. Cummings will, in good time, rise to the commanding position in Congress that his predecessor, the late Sunset Cox, had won.

A JUST DECISION.

Judge Andrews of the Supreme Court, after considering the matter for ten days, handed down a decision on the overhead wire injunctions which appears to us to be sound law, and moreover for the best interests of everybody concerned. No electrician whose opinion is worth anything would dare to say that the best interests of the public could be served by cutting all the electric light wires in the city of New York. The attempt to indiscriminately go into the subways with conductors to supply the entire electric light service would result in such a condition of things as would make the subway people wish they never had been born. It must be remembered, however, that Judge Andrews held that the overhead wires if defective must be repaired. The overhead service of New York has been improved more in the last week than in the previous year. The improvement should continue until no defective wires can be found.

THE GOVERNMENT'S TELEGRAPH SYSTEM.

An order has been issued by the War Department transferring Lieut. J. A. Swift, of the Signal Service Telegraph Bureau, from Ashland, Oregon, to Norfolk, Va. Several military posts on the Pacific Coast having been abandoned, the necessity of telegraphic communication with these points no longer exists, and, in consequence, the lines leading to them will be disposed of. After Lieut. Swift closes up the business of his district, no officer will be needed on that station. The line from Ashland to Fort Klamath, 99 miles in length, will shortly be sold to the highest bidder. Upon arriving at Norfolk Lieut. Swift will take charge of all the military telegraph lines along the Atlantic Coast from Maine to Florida. These lines consist of comparatively short isolated sections, constructed by the Government to serve as extensions of the commercial telegraph system and connect outlying points which it was desirable to reach for military or meteorological purposes. When General Albert J. Myer was the Chief Signal Officer he was an earnest advocate of a plan for having the Government assume control of and transact all the telegraph business of the country, and, although actively supporting Postmaster General Creswell in his attempts to establish a "postal telegraph," had high ambitions of himself becoming the telegraphic dictator to the Republic. With this idea permeating the policy of the Signal Service, and large appropriations at command, extensive telegraph construction was carried on, and lines put in operation which, had the scheme been consummated, would have formed a pretty solid nucleus of a Government telegraph. Changes in the administration of the Signal Office revolutionized its policy, and, for some years past, it has been selling and giving away second-hand telegraph lines. General Greeley evidently thinks he has quite enough to do to carry on the regular work of his Bureau without going into private telegraph business; and the existing commercial lines provide ample facilities for the needs of weather reporting.

Postmaster-General Wanamaker has fixed the rate for government telegraph messages. For day messages the rate is from a cent a word up according to distance; night messages three-fifths of a cent. This doesn't look much like one mill a word, which was the rate the Postmaster-General had in mind some time ago. He is better acquainted with the telegraph business now.

The decision of Judge Andrews in enjoining the Board of Electrical Control from destroying the property of the electric lighting companies, was just and sensible. Of course it was not satisfactory to the sensation-seeking daily press, but we are sure that the general public, when it considers the matter calmly, will realize that any other view on the part of the court would have been not only disastrous to the electric lighting companies, but would have established a precedent full of danger to many important and valuable interests in this and other cities.

ELECTRICAL NEWS.

What is Transpiring in Electrical Circles in the Leading Cities.

OUR WASHINGTON LETTER.

A Correction.—My informant, who stated that a Westinghouse plant was being erected at Eckington, the terminus of the local electric railroad, was in error. As a matter of fact there has been placed in the power-house of the road a Thomson-Houston 500-light self-exciting alternating dynamo. This is merely for house lighting in the village. The road is lighted by a number of incandescent lamps placed five abreast and multiple arced across the locomotion circuit.

A New Firm.—A circular has just come to hand stating, as previously announced in the REVIEW, that ex-Commissioners Butterworth and Hall, together with Messrs. Frank T. Brown and Alex. P. Smith, have formed a co-partnership for conducting a patent business. Attention is also called to the fact that Mr. Brown, who has lately resigned his position as examiner of electricity, and who has borne a prominent part in the administration of the affairs of the patent office, will take charge of all of the electrical business committed to the charge of the firm.

How is This?—A Washington man, in a communication to the *Evening Star* of this city, makes use of reasoning something like the following: The exposition of 1892 must be held by and under the authority of the U. S. Government. Washington is the only place where the Government can exercise absolute authority. Were the Exposition held in another city on ground ceded by the State to the general government, no State or city police could demand that peace or good order should prevail. No concourse of persons, or large amount of property, would trust themselves in a position where there was such conflict of authority, such as could only be remedied by change in existing laws. This is the strongest plea yet!

Light for the Capitol.—The T-H dynamo on the House side has been removed and will be shortly replaced by a U. S. dynamo of slightly greater capacity. This will give the Westinghouse people control of the lighting of the capitol. Both plants will be overhauled and put in order before Congress meets. They consist of four Westinghouse machines (two alternating and two exciters) and one U. S. machine, all run by three standard Westinghouse engines. These plants are owned by the Westinghouse Co. and the government merely pays the expenses of running them. It is expected that an appropriation will be secured at the next session with which to buy a large plant such as the need of the building will require.

The United States Electric Lighting Company, of this city, is in a flourishing condition. They have all their arc light wires underground, as well as all of their feeders for the incandescent circuits. The incandescent light mains are not all under yet, but rapid progress is being made. They operated 350 arc lights as well as an immense number of incandescent lights, and about 125 horse-power in motors. They have lately put 1,000 incandescent lights in the "Shoreham," the swell apartment house, owned by Vice-President Morton. They also expect soon to put in 500 lights in the new addition to the Arlington.

A Long Circuit.—Apropos of the recent purchase of the Brush Company by the Thomson-Houston, there is a Brush machine, a regular old timer, used by the local lighting company on a T.-H. circuit, and although only a 55-lighter, carries 59 lights, and is sometimes worked up to 61. It is on what is known as the Georgetown circuit, which is the largest in the city, and extends from the works on 14th and B streets to Georgetown College. The lights on this circuit are spoken of for their brilliancy and the conspicuous absence of flickering. So far the local company have not had a fatal accident from the electric current.

G. E. M.

Washington, D. C., Nov. 2, 1889.

OUR BOSTON LETTER.

Visiting Lynn.—At the invitation of the Thomson-Houston Motor Company, the New England Cotton Manufacturers' Association to the number of 60 visited the Thomson-Houston factories and the works of the Thomson Electric Welding Company at Lynn on Thursday. The party was in charge of General Manager Spaulding, to whose attentive courtesy much of the pleasure of the day was due. A special car was provided for the trip, and several hours were spent in a thorough inspection of the various factories and departments of the Thomson-Houston Company, the tour ending with a ride around the grounds on electric train cars. Mr. H. J. Crowley and a corps of assistants made every effort to give the visitors a clear insight of all the products and processes. At one o'clock carriages were taken for the hotel where an excellent dinner was served, after which another drive brought the party to the Thomson Electric Welding Works, where an hour or two were

spent in examining the generators and welders, the practical operation being illustrated on iron and copper rods and wires varying from two inches in diameter down to a fine wire. The visitors were surprised and pleased with all they saw and unanimously voted the day most pleasantly and profitably spent. In the party were George Wood, of the Millsite Manufacturing Company, of N. J., Philadelphia; C. E. Riley, of Riley & Gray, Boston; George W. Weeks, of the Lancaster Mills, Clinton, Mass.; Fred. W. Wheeler, of the Wheeler Condensing Engine Works, New York; J. H. Sawyer, of the Chicopee Manufacturing Company, Boston; H. B. Sawyer, of Boston; J. P. Woodbury, of Boston; Richard B. Borden, of the Troy Cotton & Woolen Company, and of Richard Borden Manufacturing Company, Fall River, Mass.; Ambrose Eastman, secretary of the N. E. Cotton Manufacturers' Association, Boston; Arthur H. Lowe, of the Parkhill Manufacturing Company, Fitchburg, Mass.; A. S. Wattles, of L. R. Wattles & Company, Canton, Mass.; A. J. Gardner and A. J. Gardner, Jr., of the Danielsonville, Ct., Cotton Company; John T. Meats, Mason Machine Works, Taunton, Mass.; Henry A. Davis, of Kitson Machine Company, Lowell, Mass.; T. P. Wattles, Mill Supplies, Sunacook, N. H.; M. F. Foster, Dennison, Texas, Cotton Manufacturing Company, Milford, N. H.; S. N. Bowne, Stark Mills, Manchester, N. H.; F. T. Dwinell, of the Boston Manufacturing Company, Boston; S. S. Spencer, Conestogo Steam Mills, John Farnum & Company, Lancaster, Pa.; W. H. Martin, San Francisco, Cal.; C. A. Sawyer, of the Boston *Advertiser*, your correspondent and others. Among the Thomson-Houston people, who gave us their time and attention during the day beside Mr. Spaulding, were G. W. Mansfield, H. C. Patterson, C. A. Bowditch, and E. W. Kellogg.

The Work of the West End Company at the old Hinkley locomotive works is progressing rapidly. A temporary plant is being installed, which consists of five McIntosh and Seymour engines, built expressly for this work, with a rating of 300 horse-power each; four large Babcock and Wilcox boilers, and 15 large generators of the Thomson-Houston type. While this work is in progress, the permanent plant is also being put in. Pole work and wiring is being done over all the city where it is proposed to run electric cars this winter. The Cambridge and Charles street line will be put in operation in a few days, and the three lines in from Franklin Park ought to be in electrical running order within two months.

A Veto Message has been sent to the Waltham aldermen by Mayor Fisher, on the order granting a location to the Newton Street Railway Company, in Waltham. The mayor takes the ground that the best interests of the community would not be subserved. The measure goes over to the next meeting.

Cost of Electrical Power Transmission.—The paper by Mr. W. S. Kelley, of the Sprague Electric Railway and Motor Company, read before the New England Cotton Manufacturers' Association on Wedesday, was one of the features of the meeting. Mr. Kelley's subject was "Cost of the Long Distance Electric Power Transmission," and in his paper presented some very valuable and interesting facts and explanations of carefully tabulated results of experiments and investigations.

The Electric Club will meet this evening at the Club Rooms on Park street, and in addition to the regular monthly business the selection of a committee on nominations for general officers and a board of directors for the ensuing year will be made.

The Electrical Glass Corporation is the name of a new company just incorporated here, for the purpose of manufacturing insulators, conduit pipes for wires and electric light globes. A small factory for making the insulators will be run in Somerville, and negotiations have been closed by which the company obtains possession of complete plant of the Sandwich Glass Company. The directors of the company already elected are Charles H. Jenkins, James B. Pennyquick, Randolph Bowlby and A. Seaver.

Lighting the Tow Cars.—The problem of lighting the tow cars attached to motor cars is one that has received some attention of late. The contrast between the brilliantly illuminated electric car and its dingy follower has been marked. Mr. L. F. Jordan, of this city, has worked out a system which has been successfully tried on the Cambridge road. A double pole coupler is employed and the current is carried to the tow car and lamps and returned through it to the grounded circuit. Switches are placed at each end of the tow car so that the lights may be controlled from either platform. If the cars should break apart, the coupler would automatically separate and no harm be done. L. F. Jordan & Company, 133 Oliver street, control the system. T. W. S.

Boston, Nov. 4, 1889.

The Postal Telegraph Cable Company opened for business at Atlanta, Ga., last month, under the management of Milton Orr, a well-known telegraph manager.

Electricity in Relation to the Human Body.

To the Editor of Electrical Review:

Under the above title, Dr. M. Allen Starr has written the electrical article in the current issue of *Scribner's Magazine*.

There is much information in the article which the general reader can gather, and many things which are interesting and unfamilar to the purely electrical reader, but with it all there is some misinformation stated so learnedly that many will take it for truth, and the author has made the almost universal mistake of medical men when writing for unprofessional readers, of expressing very commonplace ideas and describing simple things in very learned language in which Latin and Greek play a larger part than the mother tongue.

Most men indulge in this sort of thing when they are very young and before the hard knocks of life have given them a realizing sense of the fitness of things, but the Doctor sticks to his Latin as long as he can speak or write. Every Latin word is in bad use when it takes the place of a good English equivalent. It is the pedantry of half learning, and it is indeed pitiful when it is used to throw the mantle of mysticism over half knowledge. Nothing so truly indicates the educated mind as perfect simplicity and honesty of speech.

In the article in question the general subject of the generation of electricity for medical use is first treated, and quite admirably, were it not for one or two technical slips as, for example, where energy and work are used synonymously.

In speaking of "current or voltaic electricity," the author states that "it is produced by chemical action in a battery, the work done by the expenditure of energy in the chemical process being partly manifest by the electrical state produced in the elements. There is more or less chemical action going on constantly in the process of nutrition within the body and, therefore, the body may be looked upon as sort of a battery for the production of electricity." The falacy of this argument is so evident that it does not need answering, but it is a pity to have it set forth in a widely read popular magazine.

The all absorbing question of the danger from the electric light wires receives its full share of attention in this article. One paragraph is exceedingly rich; it is as follows: "The amount of electricity sent through the body is measured by a galvanometer exactly as currents in a wire is measured. But the body is so sensitive that only a few thousandths of an ampere of current can be safely borne. When it is remembered that several hundred amperes pass along the wires of an electric light, the danger of receiving a current from them becomes at once evident." Not one word is said as to how much is likely to go through one upon getting in the path of a "several hundred" ampere current, nor what part electric pressure plays in this interesting question. Further on we find this remarkable statement: "There can be no question that such a method of execution (by electricity) is more certain, more sudden and less offensive to spectators than that of hanging, and therefore it should be universally adopted in criminal execution." We are loath to believe that physicians arrive at results in the practice of medicine by loose reasoning, but they certainly have a penchant for queer logic when they treat of electrical matters.

A good example of the utterly unscientific treatment of the subject may be found in a foot note where we read that "the resistance of the dry skin (human) is about 100,000 ohms;" absolutely no data being given as to the area in contact with the electrode nor other information which would make the statement of the least value. The impression which the general reader would gather would be that any portion, large or small, of the human skin when dry would measure about 100,000 ohms. Of course, every electrician knows differently, so the statement above quoted conveys an erroneous impression to the general reader, and no impression to the electrical reader.

One more example. The writer states that cocaine may be driven through the human skin by an electric current, so as to produce local insensibility to pain. This is an old, old scheme which originated, if we remember aright, in Italy some 30 years ago. The only unfortunate thing about it is that it don't work. It was thought that as, in the electrolysis of fluids, acids tended to flow towards the positive pole and alkalies towards the negative pole, nothing would be simpler than to force an acid or an alkali into the human body by means of an electric current. It was one of those cases where theory held but experiment failed.

Nothing can be more profitable than for the leading magazines to publish popular articles on electrical subjects; but it would be well for these articles to be written in plain language and treat of what is known, and not of what is supposed or guessed.

Allan V. Garratt.

New York, Nov. 2, 1889.

Electrical Engineering at Columbia College.

The new course in electrical engineering in the School of Mines was regularly started at the opening of the college.

The building, erected specially for electrical and mechanical engineering purposes, was delayed considerably by bad weather during the summer and is not quite ready for occupancy, but fortunately temporary quarters with ample space were found in an adjoining building where, for the present, the electrical instruction is being given.

The work has begun very satisfactorily with 14 students, which is as large a number as can be advantageously instructed in the beginning. More than half of the students are already graduates of the School of Mines in civil and mining engineering, and the rest are graduates of other colleges. These men make most desirable students, as they are already well educated. In fact the requirements for admission are such that the students are sufficiently advanced to be able to give their whole time to electrical work uninterrupted by instruction on general subjects.

The regular course for the degree of electrical engineer extends over two years, it being considered that the usual one year electrical course is not sufficiently long to thoroughly teach a subject of the magnitude and difficulty of electricity, even though the entire time be given to it. There is, however, a partial course of one year for those who do not care to go so deeply into the subject for which a certificate only is given.

The apparatus for use in the course include the best American and foreign instruments, such as the large Anthony bridge, Elliott bridge, Anthony standard galvanometer, Thomson's reflecting galvanometers, large and small (by Elliott), Thomson's ampere balance, Marshall standard multiple series condenser, Elliott standard condenser, sets of 100,000 ohm coils by Anthony and by Elliott, Weston, Ayrton & Perry, Cardew & Carpenter voltmeters and ampere meters, etc.

Besides these standard instruments, there are the instruments ordinarily employed in practical work, such as portable bridge and galvanometer sets, detector galvanometers, etc.

There are also in the electrical engineering building a 100-light Edison dynamo and a 300-light Edison dynamo of recent type, which are working and available for the use of the students. The building is also connected with the Edison street circuit as well as with the Manhattan alternating current circuit, thus giving excellent facilities for experiment.

A five horse-power Sprague electric motor is in use in the buildings, and other smaller motors will be used in driving machines and apparatus in the laboratory.

Standard sets of telegraph, telephone and electric light apparatus, and primary and secondary batteries are also provided for the use of the students.

The course of instruction consists of lectures of two hours per week on principles of electricity, and three hours on applications of electricity, by Mr. F. B. Crocker, and two hours per week on electrical measurements and two hours on mathematical theory of electricity, by Mr. Michael Pupin. These lectures last from 10 to 12 o'clock each day, and the time from one to four is spent in practical laboratory work under the personal direction of the instructors. This work consists in the actual construction and testing of electrical apparatus and machines, and covers measurement of resistances, electromotive forces, currents, insulation, location of grounds and faults, tests of efficiency and constants of machines, etc.

Both lectures and laboratory work take up the subject from the very beginning, and a thorough drilling in fundamental principles is given. This is found to be very necessary, even in the most elementary matters, and is probably the most important part of the entire course.

The new course has thus started under very favorable circumstances, with every prospect of being a benefit to the college and to electrical engineering.

PERSONAL.

Mr. John I. Sabin, vice-president and general manager of the Pacific Bell Telephone Company, of San Francisco, is visiting New York, with headquarters at the Electric Club. Mr. Sabin will remain in the East a few weeks, and with Mr. Eugene Phillips, of Providence, is enjoying the sights of Montreal this week.

Mr. W. H. Gordon has opened an office, 115 Broadway, New York, under the name of W. H. Gordon & Co., and will handle general electric light and power specialties. Mr. Gordon has a number of friends in the electrical field who will be glad to hear that he has decided to identify himself with this industry in the East.

The marriage of Miss Sarah Lavinia Barney, of Hackensack, N. J., daughter of Gen. C. H. Barney, secretary National Telephone Exchange Association and treasurer of the Sawyer-Man Electric Company, to Mr. Charles Hanford Carter, of New York, occurred on Wednesday evening, October 30, the ceremony being performed at Christ Church by Rev. Wm. W. Holley, D.D. The reception was held at the residence of the bride's parents. A large number of very handsome and valuable presents were received. The young couple will reside in New York City.

Mr. Abdank-Abakanowicz was honored with a dinner at the Café Durand, Paris, recently, the American exhibitors in the electrical section of the Paris Exposition doing the honors. Mr. J. Draper Bishop, of the Western Electric Company, presented guests of the evening with a handsome box of the finest silver and china as a testimonial of appreciation on the part of all the electrical exhibitors from the United States. Mr. Bishop's address was very felicitous, and the occasion was particularly enjoyable. Monsieur Abdank has been ever zealous and courteous in securing for the electrical exhibitors from this country all possible conveniences and privileges, and the testimonial was very appropriate.

The successor to Mr. Brown, the late examiner of Electrical Division A of the Patent office, has not yet been appointed. The work of the division is being conducted by Charles M. Catlin, who has been in this office for seven years, and who now will be made principal examiner if the regular order of promotion is followed. He has had special charge of all matters pertaining to telephony, while Mr. A. P. Knight has had most to do with telegraphs, fire alarms, burglar alarms and indicators, and Mr. W. A. Cowles has given his time to arc and incandescent lights. Division B has jurisdiction over electrical generation, distribution and locomotion, and is under the general supervision of Examiner Geo. D. Seely. In this office the subjects are divided as follows: Locomotion, Mr. A. P. Greeley; systems of electrical distribution, Miss Sarah J. Noyes; galvanic and secondary batteries, Mr. A. P. Shaw; alternating current motors, Mr. W. M. Fairfax; dynamo electric machines, Mr. H. O. Binney; miscellaneous, Mr. H. S. Mackaye. A great many applications for patents for inventions containing some electrical feature, such as electric clocks, electric toys, etc., go to other divisions in the office.

ELECTRIC LIGHT NEWS NOTES.

—— It is reported that a syndicate will buy the New Berne, N. C., gas work and establish an electric light plant.

—— The Basin Mills, Orono, Mass., the largest lumber and box mills in New England, are now lighted throughout by electricity.

—— The directors of the Woodward Electrical Company, of Detroit, have been authorized to sell the company franchises, etc., to pay its debts.

—— The city of Hastings, Neb., boasts of being the best lighted city of its size in the State. There are now in use 1,200 incandescent and 55 arc lights.

—— The Rockville (Conn.) Gas Company voted to increase the capital stock $25,000 to provide for the expense of the change in the gas plant for the new electric light plant.

—— The entire central plant of the Laconia, N. H., Electric Light Co., is to be moved and located on the premises of a local saw mill. This will enable the lighting company to have abundance of power and afford them facilities for extending their business.

Telephonic News

⁂ San Salvador is the first of the Central American republics to establish telephone service throughout its territory.

⁂ The treasurer's office of the Hudson River Telephone Company is to be removed from New York to Albany, N. Y.

⁂ The telephone exchange in Findlay, O., has now a total of 178 instruments in use, making it much the largest exchange in that part of the country with the single exception of Toledo.

⁂ Man at telephone (trying to find out who has rung the call)—Hello, there, are you Thirty-seven? Young lady at the other end (indignantly)—No, you horrid thing, I'm only seventeen!

⁂ The telephone people of Salt Lake City, Utah, are kicking against the electric street cars, claiming that the frequent contact of the wires of the street car line with the telephone wires is the cause of accidents and a menace to their employés.

⁂ C. Benedict, of Jacksonville, Fla., has invented an arm rest to be attached to the telephone sets. With this invention the arms enjoy perfect rest while one is receiving or sending messages. A part of the device takes the place of a desk, so that the messages can be written down as they are received.

⁂ O. E. Bailey, of Selma, Ala., has accepted the responsible position of chief inspector for the Atlanta Telephone Exchange, and will no doubt make a success of the position. The Atlanta Exchange has over 1,000 subscribers using the Law system, and is noted for its fine service. Of course there are some subscribers who complain, but as a rule, they nearly all admit the service is very quick.

⁂ Petitions are being circulated among telephone subscribers in Lowell, Mass., remonstrating against the extension of an electric system to the entire system of street railways. The remonstrance is prompted, it is claimed, by the fact that telephone service over lines near that portion of the Lowell and Dracut road, where the trolley electric system in now in use, is rendered at times almost wholly useless by reason of induction. A petition for permission to use electricity on all the street railroad lines is pending before the city council, and is to be heard this week.

⁂ The issue between the telephone people and the electric railway interests at Lowell, Mass., is bound to become an interesting point of discussion. It is simply a question as to which party in this contest will be obliged to spend the money to make the telephone wires independent of the influence of the electric railway wires. By metallic circuits the telephone could accomplish the purpose; by the double trolley wire the electric railway people could obviate the difficulty. Shall the telephone, or the electric railway, be called upon to put its hands into its pockets? Who got there first?

⁂ The report of the Northwestern Telephone Exchange for the year ending June 30, 1889, has been filed with the State auditor. It shows the gross earnings within Minnesota for the year to be $223,248.45. There were paid out in royalties as follows: Bell Telephone Company, $47,787.18; Western Electric Company, for switchboards, $1,091.67; the same company for material, $206, making a total of $49,084.85. The total taxable earnings amount to $174,163.60, and the two per cent. tax on this yields the State $3,483.27. The cities embraced in this report are: Albert Lea, Faribault, Fergus Falls, Minneapolis, Mankato, Northfield, St. Paul, Stillwater and Winona.

⁂ It is said that the Erie telephone net earnings for July and August were $41,000, against $8,400 the same two months last year.

⁂ A system of underground construction has been recently adopted by the Southern New England Telephone Company, at New Haven, Conn. The contract is for 15 miles of ducts. The number of ducts varies from five to 24. Through each of these ducts a cable of 100 or more wires passes, in some instance as many as 200.

⁂ A telegraph company has been organized at Oleander Colony, 10 miles from Fresno, Cal. O. B. O'Lufs is president, Captain Fernald vice-president, and D. C. McLaughlin, secretary and treasurer. A contract has been let for the construction of a line which will tap the Western Union system at Fowler, and be completed in one month.

⁂ A novel electrical contrivance for the announcing of approaching stations was experimented with on a passenger train on the Lehigh and Susquehanna division of the Jersey Central Railroad. Over the door of each passenger coach is attached the name of each station on the line. By the pressing of a button in the baggage car the name of the station is changed to the next one to be stopped at, and a bell is rung to attract the the passengers' attention to the change. The names are sufficiently large to admit of them being easily read at the furthest part of the car.

A New Electrical Register for Horse Cars.

A series of buttons along the inside of a horse car within easy reach for the conductor connect with the register at the end of the car in somewhat the same manner as the present existing arrangement. By pressing one of these buttons the fare is registered and the announcing bell rings simultaneously. In the system used at present the conductor pulls the leather strap which rings the bell and the fare is registered by the return action of the belt. It is said that in the present method the gong can be rung without registering the fare by skillful manipulation. Again, in unloading a ship, switches can be so arranged that each parcel of a similar size, as in tea cargoes, registers as it passes the electrical connection The same device can be applied in a pork packing establishment, or in any place where it is necessary to record repeated action.

Electricity in Coal Mining.

A Scranton, Pa., paper in describing the application of electricity at the mines of the Hillside Iron and Coal Company, says:

"The dynamo which is to furnish the power is placed in the engine house at the head of the shaft. The electricity is conveyed from the dynamo by means of a wire which is encased in a pipe to prevent any accident from occurring from contact with the cable. It is thus brought to the bottom of the shaft, a distance of 160 feet. From here it runs along the main heading, which is about 2,000 feet long. The cable is about six feet from the rail and is on the left side of the heading. The motor car is constructed much on the same principle as the street car, but the trolley, instead of being attached to the center of the car top, is on the left side. The object of this is to make it less easy to come in contact with the bare wire. The cable will carry only 200 volts of electricity.

"It is expected that this small force will pull or shove 20 loaded cars. It will dispose with the services of from seven to ten mules on this heading alone. Of course it is not expected that mules will be entirely excluded from the mine. They will be still used in hauling the cars from the chambers to the various headings. They will be used also for the present in drawing the cars along the sub-headings to the heads of planes and *vice versa*. The wire which brings motive power to the car will also feed several incandescent lamps which will furnish light to the main heading. The use of electricity in this heading is only a trial. If successful here the company will work the seven other levels of the mine in the same way. Some of these levels are 400 feet long, nearly twice the length of the heading on which the trial is to be made. The use of electricity will give the mine greater capacity of tonnage and will aid the miners in supplying them with cars without having to wait for them. This mine has a capacity of 1,000 tons a day, in this respect being qualified by few mines in the coal regions. The Hillside Coal Company have besides the 'Erie' two other mines, the 'Keystone' and the 'Glenwood,' near Mayville."

Some Methods of Regulating Accumulators in Electric Lighting.

BY GEORGE B. PRESCOTT, JR., BEFORE THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, NEW YORK, OCTOBER, 29, 1889.

In preparing the following paper, the limited scope of which is indicated by its title, I have assumed that is is generally conceded that the modern electric accumulator is an apparatus capable of performing a peculiar but useful function in the art of electric lighting as now commercially practiced, and that it is free from inherent defects which would render it unsuitable for such application. Indeed, I am sure that every careful observer has noted in the somewhat slow evolution of the accumulator, that structural improvement and adaptation to practical requirements, which unquestionably show that it has come to stay; and will acknowledge that even as it exists to-day, the accumulator is a factor in electrical industry too important to be ignored by those who take a broad view of the situation.

It is not my intention to refer to those numerous successful applications of accumulators to the propulsion of small marine vessels and land vehicles, to car lighting and other minor work where the continuous generation of power from the combustion of fuel would be impracticable; neither can I fully discuss their characteristic actions under working conditions, within the limits of this paper. Nevertheless, before proceeding to the subject proper, I deem it incumbent to point out that the electrical accumulator, even in its more improved forms, is an apparatus having well defined limits of capacity, and that these limits cannot be habitually exceeded without endangering its effectiveness and impairing its durability. Generally speaking, the limits referred to, which vary with every type and size of cell, relate to the rate and quantity of charge and discharge, these factors being measured respectively in amperes and ampere-hours.

In considering this admission, however, it should not be forgotten that every dynamo-electric machine is, to a certain extent, subject to similar limitations; for, like the accumulator, if it is demanded of them, they are capable of generating a current far exceeding their safe carrying capacity. Here the likeness ceases, however, for while the dynamo will deliver its normal current as long as adequate power is applied to its shaft; by continuing to draw current from an accumulator for too long a time, as likewise from an excessive rate and quantity of charge, serious damage may result. In fact in some respects an accumulator may be likened to a draught animal, which can be made to perform abnormally large amounts of work for short periods of time, but only at the expense of its vitality if the practice is frequent.

While much might be said regarding the maintenance of accumulators, and, moreover, the apparatus to be presently described is employed in a large measure for the purpose of effecting proper maintenance as well as regulation, it must suffice to say here that the normal working rate and capacity of an accumulator battery having been stated by the makers, all necessary data relating to its use may be ascertained from the indications of ordinary hydrometers, ammeters and voltmeters. That is to say, during the charge and discharge of such a battery the rise and fall of its potential and of the specific gravity of the electrolyte in its cells, are both quantitatively indicative of its condition and capacity for doing work. It is evident from what has already been said regarding the importance of working accumulators within certain prescribed limits, that in order to effect this result two classes of apparatus must be provided with every accumulator installation, viz: indicating or measuring instruments, and regulating appliances to be operated either automatically or by hand. I am constrained to add here that careful and extended observation leads me to believe that a lack of appreciation of these now obvious facts will largely account for the ill success attending many of the earlier accumulator installations.

Although there is reason for believing that some of the early promoters of business enterprises, based on the manufacture of electrical accumulators, anticipated that accumulator systems of lighting were destined to compete with and perhaps supersede many direct systems, I believe that the more mature modern idea is that they are, for the present at least, mainly subsidiary to other electric lighting systems. As auxiliaries to many direct systems, accumulators undoubtedly effect a reduction in running expenses and add an element of reliability, besides accomplishing certain results that are not otherwise obtainable. In order to fully appreciate the truth of these statements, it will be necessary to glance at the conditions commonly existing in ordinary isolated and central station plants as they are operated at the present time. Doubtless every one who is familiar with the electric lighting business is acquainted with the vagaries of the load curves during each 24 hours of a central station's run. Generally speaking, about sunset the load begins to increase gradually, finally reaches a maximum which is maintained for a greater or less period of time, and then falls to a minimum about which it fluctuates for the remainder of the 24 hours. Almost every isolated plant, whether it be in office building, hotel or apartment house, has a curve of the same general character; and probably most manufacturing establishments would prefer to have a few lights burning through the night, if only for the watchman's convenience, were it not for the expense entailed by the continuous operation of the plant. It is a truism to say that the cost of fuel per horse-power increases inversely as the power plant operates below its normal capacity, and that other operating expenses are, to a considerable extent, fixed independently of the load. In view of these facts it is universally acknowledged that the operation of large power plants of any character during periods of light loads is enormously wasteful. Many have hoped that the supplying of current to small electric motors during the day would remedy the evil in lighting stations, and to some extent the expectation has been realized in manufacturing centers, but even here the unfortunate overlapping of the motor and lamp service still leaves an undesirable margin.

Here, then, is a field in which accumulators may perform their special function; not in competition with direct systems, but as supplying the missing feature in the commercially successful operation of 24 hour plants of moderate size. There is no obstacle in the way of applying a sufficient number of accumulators to a plant of the character mentioned to maintain the light load during the time it would not pay to operate the power plant, and to provide for the charging of the accumulators during the regular running time of the dynamos. Assuming, in illustration of this statement, that 10 hours is the ordinary working day, and that the engines of a central lighting station are started at 2 P. M., and are operated until midnight, it is probable, if not certain, that there will be sufficient surplus current for an ample length of time to charge enough accumulators for the service required after the engines cease to revolve; excluding, of course, the period of maximum load, when the dynamos will be taxed to their full capacity in their regular service. Under such conditions the engines could be operated at somewhere near their normal capacity during the whole period of their running time, and the cost of unit power would be a minimum; while only one staff of men will be required. It may be advisable to explain here that although the current available for charging the batteries during the regular running time of the dynamos would vary with the lamp load, this is of no importance, as it is not essential that the batteries should be charged at a uniform rate. In the case of such stations as also supply arc lights, the engines could be started later and operated through the night. Besides reducing the operating expenses of a station during its periods of light load to a greater extent than they increase them at other times, in the event of an accident to the power plant or incandescent dynamos, the accumulators can always be called upon for extra service; while whenever there is an abnormally heavy demand for current they may also be operated in conjunction with the dynamos.

But there is still another field in which accumulators may be employed to equal advantage, viz:—that of long-distance lighting now so successfully occupied by the alternator-converter system. An accumulator is indeed merely a chemical converter, which is unequaled as a pressure-reducer, and any one who gives careful thought to the subject will perceive what an excellent substitute it is for the alternator-converter in those situations where the character of the lighting makes it necessary to run "light" for many hours each day. Indeed I can only account for the fact that accumulators were not long since more extensively used for this class of lighting, except by the existence of a feeling of skepticism as to their durability, together with their somewhat formidable first cost.

As manufacturers now guarantee the durability of accumulators, under certain conditions of use, for an annual percentage on their first cost; and as methods of manufacture must improve with experience and moderate that cost, both of these objections are gradually being modified.

But even in the present state of the art, the question of first cost, depreciation and efficiency may be duly allowed for, and a considerable reduction in operating expenses still shown to result from the use of accumulators under any circumstances. To quote from an article by the writer "On the Place of Accumulators in Electric Lighting," which was published in the March issue of *The Electrical Engineer*:

Whenever one kind of energy is transformed into another kind, more or less loss can be shown to occur, and the action of the accumulator is not an exception to this rule. The proportion of loss generally varies with the conditions under which the transformation is effected, and in the case of the accumulator depends mainly upon the rate of charge and discharge. If these double transformations are conducted slowly the loss may be nearly

inappreciable, but at the higher rates which are frequently demanded in practice the efficiency is proportionately reduced. The fact of the existence of this loss clearly indicates that the direct production and consumption of electricity must always be less expensive, both in original outlay and cost of production, than its subsequent use through the medium of accumulators; unless, indeed, there are other modifying conditions which overbalance the additional cost of accumulators and offset their maintenance. That such conditions do exist in many branches of the electric lighting industry can be readily demonstrated, and it may likewise be shown that the use of accumulators as auxiliaries to many existing lighting plants would insure a marked reduction in their running expenses.

* * * * * * *

From what has already been said regarding the infallible certainty of loss resulting from any form of conversion of energy, it is evident that if the load were equal to the capacity of a plant for 24 hours each day no system of conversion could compete in point of economy with one which effected the direct production and use of the current. There is an exception even to this general statement, however, when one or more groups of lamps are located at such a great distance from the source of power, that the interest on the cost of conductors, together with the cost of the energy wasted in them, becomes of serious importance; not to mention the increased difficulties of regulation. In cases of this character, the value of the accumulator as an auxiliary to a direct incandescent system becomes obvious. The cells may be located directly at the centers of consumption and charged by a moderate current at high pressure over a small conductor. They may be charged during the hours of light load and discharged as required, the whole charging current, in addition to the current of the batteries, being available on the lamp circuits, during the period of maximum load, if it should be so desired. Often the interest on the cost of such an accumulator installation, plus the cost of the energy lost in conversion of current, is much less than the loss by the direct system as previously specified. Another and vastly important consideration in favor of the accumulators is that during the 10 or 12 hours of each day when the consumption of current is so small that a station can only be operated at a loss, the power could be shut off entirely and the accumulators resorted to for the current required during that period.

As a matter of fact, the ideal condition of a continuous maximum load, as assumed above, nowhere exists in practice. The actual load curves for stations of simi ar capacity throughout the country differ not only in respect to the duration of the maximum period, but likewise in the hours during which the light and heavy loads occur, according to the character of the lighting. It is nevertheless true that they all show a remarkable similarity in the variation of current consumption, and all the 24 hour stations, particularly the smaller ones, require but a very small portion of the capacity of the plant for the greater part of the day. For this reason, many of the smaller stations cannot be profitably operated for more than 12 hours a day, and customers are therefore unable to obtain the light for the remainder of the 24 hours, the system being thereby deprived of much of its value to many consumers.

Here again the utility of the accumulator for tiding over these costly periods of light loads becomes apparent. It is evident that any ordinary station running for 12 hours a day, more or less, is not likely to have an output approaching its capacity for more than two hours at the longest, while for the greater part of the time it will be much below it. Why should not such a station be operated during that period of 12 hours at somewhere near its full capacity, and, therefore, under the most economical conditions for the power produced, and utilize the excess of current to charge a sufficient number of accumulators to maintain the lighter load during the remainder of the day?

This is the legitimate work of accumulators, and when they are properly installed and maintained to meet such conditions, the class of small stations referred to will be enabled to supply satisfactory light for 24 hours a day at moderate cost, while the larger stations may greatly reduce their running expenses and at the same time maintain the efficiency of their service.

Before proceeding to consider the methods of regulating accumulator currents, it will be advisable to examine some of the peculiarities of the element with which we have to deal. Generally speaking, the total current capacity, expressed in ampere-hours, of a single cell of accumulator of the lead lead-oxide type, is proportional to the number and size of its plates; its rate of discharge depending upon the number of plates and the effective surface of each, while the time of such discharge varies with their thickness. Although there are no obvious theoretical reasons why a single cell of accumulator should not be made sufficiently large to possess any desired capacity, there are mechanical considerations which make it advisable to limit the dimensions of a cell to the extent that it may be conveniently portable. Therefore when higher rates or longer discharges than an ordinary cell will give are demanded, two or more cells must be connected in parallel. On the other hand, the electro-motive force of all sizes of accumulators composed of the same elements is of course identical, but as the internal resistance of a cell varies with the number and surface of its plates, its effective working potential must be a function of the strength of the discharge current. As, however, the internal resistance of all sizes of accumulators is, in virtue of the large surface and compactness of their electrodes, exceedingly small in comparison with their rate of discharge, their working potential nearly equals their electro-motive force on open circuit. While the normal effective working potential of a fully charged accumulator in good condition is usually stated as about two volts, as a matter of fact it is somewhat higher than this after being charged and rather lower after normal discharge, the average effective potential being about 1.95 volts. During the operation of charging an accumulator, its potential, or what is then usually called its counter electro-motive force, rises gradually until the cell is nearly charged, and then more suddenly as gas is evolved, sometimes requiring an effective charging pressure of as high as 2.5 volts per cell if the current is continued after the cell is charged. In actual practice the accumulator is usually considered to be fully charged when the potential of the normal charging current reaches 2.3 volts per cell, or at 2.2 to 2.25 volts per cell when the charging rate is reduced as gas begins to be freely evolved towards the end. Similarly when a cell is discharged at the normal rate its effective potential falls during the progress of the discharge from 2 volts to 1.8 volts, at which latter point it is considered to be discharged to its normal limit.

The facts above cited to the effect that the electro-motive force of accumulators rises during charge, and falls during discharge, and that their capacity for charge and discharge is limited, are the key notes to the regulative processes; and only one other point need be here considered. When two or more series of cells connected in parallel are to be charged at the same potential, it is evident that, unless each series is in precisely the same state in respect to residual charge, there will be a difference in their electro-motive forces; and, in consequence, less current will flow in those series having higher potentials than others. While the larger current flowing into the less charged cells will have a tendency to bring up their potentials to the average, it is found in practice that some series will become fully charged sooner than others. The simple means provided for compensating for these variations will be duly described.

One of the commonest, and perhaps the simplest, applications of accumulators to lighting work is found in their employment in connection with direct isolated plants in factories, office buildings, etc. In illustration of the method of applying accumulators in such cases, we may select as a type of this class of lighting one of those office buildings common in New York and other large cities. This building, we may assume, has already been, or is about to be, wired for 500 16 candle, 100-volt, ½-ampere lamps on the multiple arc plan, and is to be provided with a 125-volt, 200-ampere dynamo; it being calculated that more than 400 lamps will rarely be lighted simultaneously. We are not specially concerned with the power plant, and will simply assume that it is of ample capacity, it being remembered that such buildings are usually steam heated, and therefore, offer favorable conditions for the operation of a plant of the character under consideration. Now it can be deduced from experience that, during the day, from say 9 o'clock in the morning until about sunset, only a limited number of lights will be burned in certain dark corners of the building, and that as twilight and darkness come on the load will gradually increase, reaching a maximum at a certain hour depending upon the season; subsequently the load will decrease, finally reaching a minimum after the janitor and his assistants have finished their cleaning operations, which load will probably be maintained for the remainder of the 24 hours. It is evident that a direct plant operating under such conditions would necessitate the employment of two forces of men, either one or two in each, and would, moreover, be running under exceedingly uneconomical conditions for a large part of the time. Let us now consider in what manner accumulators may be added to this plant in order that it may supply the variable load for 24 hours daily, while at the same time dispensing with the services of one staff of men and reducing the running time of the engine to eight hours.

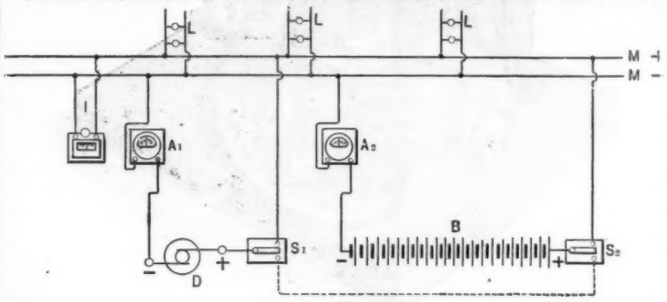

Fig. 1

It has been shown in a general way how the load varies during 24 hours: but in order to ascertain the capacity of the accumulators required, it will be necessary to assume, though only approximately, somewhat more precise figures. Say that the load is as follows:

From 9 P. M. to 9 A. M.,	20 lamps	=	120	ampere-hours.
" 9 A. M. to 4 P. M.,	200 "	=	700	" "
" 4 P. M. to 6 P. M.,	400 "	=	400	" "
" 6 P. M. to 9 P. M.,	50 "	=	75	" "

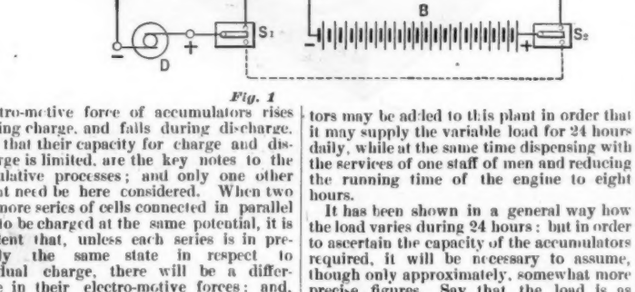

Fig. 2

FIG. 4.

An inspection of the above schedule shows that for 12 hours out of the 24 only 20 lamps, or 10 amperes, are used, while for three hours more only 50 lamps, or 25 amperes, are required; and a simple calculation proves that a set of accumulators having a capacity of 200 ampere-hours will be amply sufficient to maintain the light lamp load for 14 hours out of the 24. If the dynamo is started at 8 A. M. and operated until 6 P. M., while maintaining the required number of lamps during that period it will still have surplus current for charging the battery as follows:

From 8 A. M. to 9 A. M., 100 amperes for 1 hour.
" 9 A. M. to 4 P. M., 100 " " 7 hours.

or 890 ampere-hours, an available capacity vastly in excess of the requirements. Now, if during the eight hours in which the dynamo is operating the accumulators are charged at the rate of 30 amperes, in that period they will receive a total charge of 240 ampere-hours. According to the schedule, the maximum output required from the battery will be 185 ampere-hours, whence it follows that the charge received by it is more than ample, even after making the customary allowance of 20 per cent. for loss by conversion; and the desired result has been accomplished.

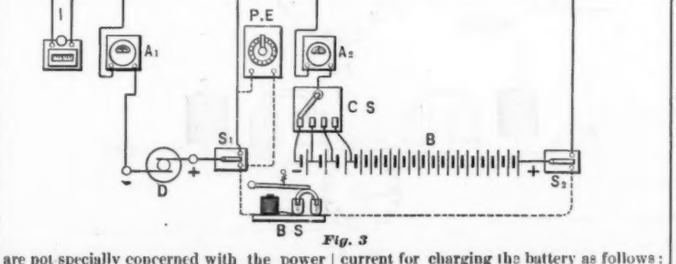

Fig. 3

We have now to consider the details pertaining to the practical arrangements of such an installation. According to the stipulated schedule, after the dynamo ceases to run at 6 P. M., the battery alone must supply 25 amperes for three hours, and thereafter 10 amperes for 11 hours, or a total output of 185 ampere-hours. One series of 50 cells, having say a normal capacity of 30 amperes for eight hours, will satisfy these requirements, and will be well within the nominal rating of ordinary commercial cells. Assuming that these 50 cells, connected in series, have been suitably placed on insulated shelving at any convenient distance from the dynamo, they may be electrically connected with the latter and with the lamp circuit, as shown diagrammatically in Fig. 1.

In this diagram the two parallel wires *m* (+), and *m* (—), represent the common dynamo and lamp mains to which the pessure indicator, *i*, is permanently connected in the usual manner; and *l l l* represent the lamp circuits. The dynamo, *d*, is connected to the mains through the ammeter, a_1, on one side, and through the upper contact of the two way switch, s_1, on the other. These are the ordinary connections of a multiple arc plant; and the (+) and (—) terminals of the accumulator battery, *b*, are also connected with the mains through the ammeter, a_2, and two-way switch, s_2, in precisely the same way. It is evident that if the levers of both switches, s_1, s_2, are against their upper contacts, the dynamo and battery will supply current to the lamp circuits in exactly the same manner as would two dynamos connected in parallel, provided, of course, that they are both at the same potential. On the other hand, if the potential of the dynamo slightly exceeds that of the battery, the current from the former will divide between the battery and the lamp circuit in a certain proportion determined by the ratio of the resistance of the lamp circuit to the internal resistance and counter electro-motive force of the battery. If the levers of the two switches, s_1, s_2, are now moved to their lower contacts, the dynamo and battery will be connected in series with their like poles opposed, the main, *m* (—), acting as part of the circuit; and supposing that the pressure of the dynamo still exceeds that of the battery, the latter will receive a charge. Thus, by this very simple arrangement, the dynamo and the battery, either separately or together, may be connected with the lamp circuit, or with each other, or be entirely disconnected.

While this method satisfies all but one requirement in certain classes of plants where it is convenient to employ the dynamo solely for charging the battery during a part of the day, and to use either the dynamo or battery, or both, in the lamp circuits at other times, it does not, in fact, satisfactorily permit of that splitting of the dynamo current between the lamps and battery which was incidentally referred to. More than this: it fails to provide a means of compensating for that rise and fall of the potential of the battery during charge and discharge which has been mentioned; and this is the unsatisfied requirement referred to above. The reason why the dynamo cannot satisfactorily divide its current between the battery and lamps when connected in the manner illustrated in Fig. 1 has already been pointed out. During the charging of the battery its potential will rise to 2.2 volts per cell, so that the pressure of the dynamo must be raised to 110 volts in the case now being considered, and this excessive pressure would endanger the life of the lamps. How, then, will it be possible to employ the higher pressure demanded by the battery and at the same time supply current to a number of lower voltage lamps without raising their candle-power above normal? The answer is easily given, for it is only necessary to insert a suitable resistance in the main between the dynamo and lamp circuits in order to accomplish the desired result. Such a resistance, usually called a "pressure equalizer," should be made of wire sufficiently large to safely carry the current for the greatest number of lamps likely to be required at the time when the dynamo which supplies them is to be simultaneously called upon to charge the battery, and should be made conveniently adjustable as the fall of potential through it varies with the current. The method of regulating the working potential of the battery is equally simple, for it merely consists in adding to, or subtracting from, the number of active cells in circuit. This is accomplished by means of a multiple-point switch, called a cell-regulating switch, shown diagrammatically in Fig. 2, which is so constructed that, in the act of shifting the cells in and out of circuit, it neither interrupts the circuit nor short circuits the cells. It consists essentially of a single pivoted lever, which carries on its outer end a short metallic arm. This arm is attached to the lever by means of a block of insulating material, but is electrically connected with it by a short spiral of german silver wire. The lever and arm may be made to pass over a number of contact strips, which are so arranged that, before the lever breaks contact at one strip,

the arm comes in contact with the next strip, and the reverse action takes place when the lever is moved in the opposite direction. During the brief interval while both lever and bar are in contact with adjacent strips, the cell connected to those strips discharges a feeble current through the spiral of wire.

It is necessary to mention here, that in practice it is customary to provide for the installation of 10 per cent. more cells in each series than a simple calculation on the basis of two volts per cell would show to be necessary. Thus a plant using 100 volt lamps would require 100 ÷ 2 = 50 cells + 10 per cent. of 50 = 5, or 55 cells in each series. This allowance is usually sufficient to compensate for the fall of potential during discharge, as well as to provide for the ordinary loss of potential in the lamp mains.

The method of employing the pressure equalizer and cell-regulating switch is shown in Fig. 3, this diagram being otherwise similar to Fig. 1, with the further exception that an automatic break switch, *b s*, is inserted in the branch wire connecting the dynamo and battery through the lower contacts of the switches s_1, s_2. The function of the automatic break switch is merely to interrupt the charging current, in the event of the potential of the dynamo becoming so much reduced from any cause as to allow the battery to overcome it, and perhaps reverse its polarity. This switch, a practical form of which is shown in Fig. 4, consists of a simple electro-magnet with a weighted armature lever, carrying at one end an ∩-shaped bent wire dipping into mercury cups. The charging current passes through this magnet, and from one mercury cup to the other through the bent wire. When the current becomes greatly reduced to any predetermined extent, gravity overpowers the attractive force of the magnet, its armature is released and the bent wire being drawn out of the mercury cups the circuit is broken. By referring to the diagram in Fig. 3, it will be seen that the pressure equalizer, *p e*, has been so placed that when the switches, s_1 s_2, are on their lower contacts, the current from the (+) pole of the dynamo will divide at switch s_1, part going through the battery and part through the pressure equalizer to the lamp circuits, both currents again uniting at the *m* (—), main to return to the (—) pole of the dynamo. By this arrangement the potential of the dynamo may be adjusted to the requirements of the battery, and at the same time the pressure at the lamps suitably reduced by adjusting the resistance of the pressure equalizer.

When the proper balance is once obtained, and by means of this apparatus it may be quickly and easily accomplished by one man, no further attention than would ordinarily be given to the dynamo would be necessary, for although the counter potential of the battery would gradually rise toward the end of the charge and the current passing into the battery become correspondingly reduced, this result is even desirable, as it is somewhat advantageous to reduce the strength of the charging current as the battery becomes filled. In some installations, however, the extra or regulating cells are used to a more limited extent than the others, and thus having had less current taken from them, they become sufficiently charged in a shorter time. A simple movement of the cell-regulating switch will then serve to cut out of circuit one or more of the charged cells as may be required, while the others receive current for a longer time. In some cases a further adjustment of the field rheostat of the dynamo and of the pressure equalizer may afterwards be required, and if so, are quickly effected.

The first indication that the cells have received nearly enough charge will be given by the gentle evolution of gas which gradually increases thereafter, and which should never be allowed to become violent. At the same time the potential of the battery will approach 2.2 volts per cell, and even reach above 2.3 volts per cell when the gasing becomes marked. In order to take advantage of this indication of charge, it will be sufficient to have a voltmeter conveniently located, and connected with the terminals of the battery, by means of which instrument, the number of cells in the battery being known, the potential per cell is readily ascertained. While this increase in potential is taking place, a similar variation in the density or specific gravity of the electrolyte in the cells also occurs, but this change, unlike that of the potential, remains fixed, even after the charging current is discontinued. That is to say, if the specific gravity of the liquid was 1.160 when the cells were normally discharged, it would rise to 1.190 when they were fully charged, and would remain at that for a considerable length of time if no current was drawn from them. This rise of 0.030 in the specific gravity of the electrolyte is about the average increase in density which takes place in the common types and sizes of accumulators when 1.160 acid is used in the original charge, and when the range is from normal discharge to full charge. It often happens, however, that charging is commenced when the cells have more or less residual charge, and in this case the rise in specific gravity will be correspondingly less; while on the other hand it will be correspondingly greater if the cells were previously overdischarged. Again, if unusually large containing cells enclose the piles (as the aggregation of electrodes is commonly designated), the rise of specific gravity will be smaller, and on the other hand, larger if unusually small containing cells are employed. As heretofore stated, a similar drop in specific gravity and potential occurs when the cells are discharged, which in degree has about the same value as the rise. This variation in specific gravity is explained by the formation of lead sulphate during discharge, which implies the absorption of acid from the electrolyte, and by the reduction of this sulphate during the charge when the electrolyte is strengthened.

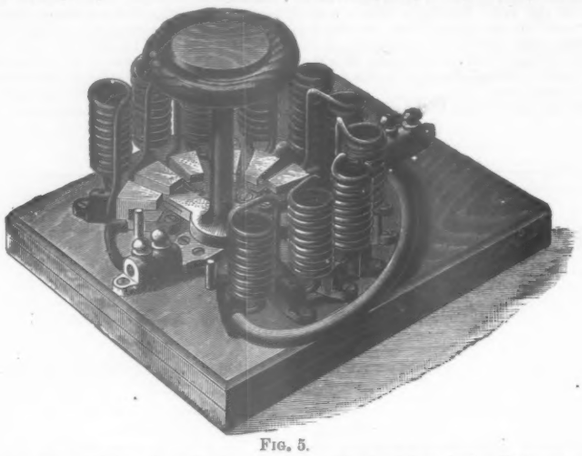

Fig. 5.

While the method of installing a single series of accumulators in connection with an isolated plant, as described and illustrated in Fig. 3, fulfills most of the conditions required in small plants operating a single dynamo, in larger plants of a similar type using two or more dynamos, several series of the largest cells may be required. Although such an installation would consist mainly of an amplification of the system already described, still there exists a new difficulty not met with in that system. This arises from the fact already mentioned, that when several series of cells are charged in parallel, any essential difference in the amount of the residual charge in the several series, results in their allowing different amounts of current to flow through them, although all of the series are charged at the same potential. The remedy for this undesirable result is of the same character as that employed to prevent excessive pressure on the lamp circuits, when the dynamo which supplies them with current is at the same time used to charge accumulators. In circuit with each series of cells is placed a small adjustable resistance coil, called a current equalizer, a cheap practical form of which is shown in Fig. 5. It is composed of wire large enough to carry the maximum current of a single series of cells, and usually has a resistance of from $\frac{1}{10}$ to $\frac{1}{20}$ of an ohm. Each series of cells is also provided with an ammeter, and upon the commencement of a charge the current equalizers are so adjusted that each ammeter shows the same amount of current to be passing through each series. In order to avoid as much as possible any loss of energy in the current equalizers, they are all turned to the non-resistance point at the start, and resistance is then only inserted in such series as may be taking more current than others.

The general arrangement of an accumulator plant consisting of two dynamos and two sets of batteries is illustrated in Fig. 6, and a simple extension of this plan only is necessary to adapt any number of series of cells to a plant having any number of dynamos. It will be seen that one equalizer circuit, and one charging circuit with its automatic cut-out, are common to all the dynamos that may be used. While this arrangement possesses all the flexibility of the method of installing a single series of cells, as shown in Fig. 3, it has the additional advantage that at such times as the load is below normal, a spare dynamo can be exclusively employed for charging the cells, and thus avoid loss of energy in the pressure equalizer. As a general thing when the current equalizers, *c c*, have once been adjusted at the beginning of a charge they need but little if any further attention, still, if from any cause one series of cells should happen to be overdischarged, or discharged more than the remaining series, a suitable readjustment of the current equalizers will permit the undercharged series to receive current at a higher rate than the others, and thus equalize itself with the others. It may also be mentioned that both the pressure and current equalizers may be made to operate automatically by the application of a potential magnet to the former and of a current magnet to the latter, together with a simple but somewhat expensive train of gears to move their levers. This is found to be wholly unnecessary in practice, however, as an engineer is usually in constant charge of such a plant while the dynamos are running, and he can easily devote the little time necessary to the infrequent regulation required.

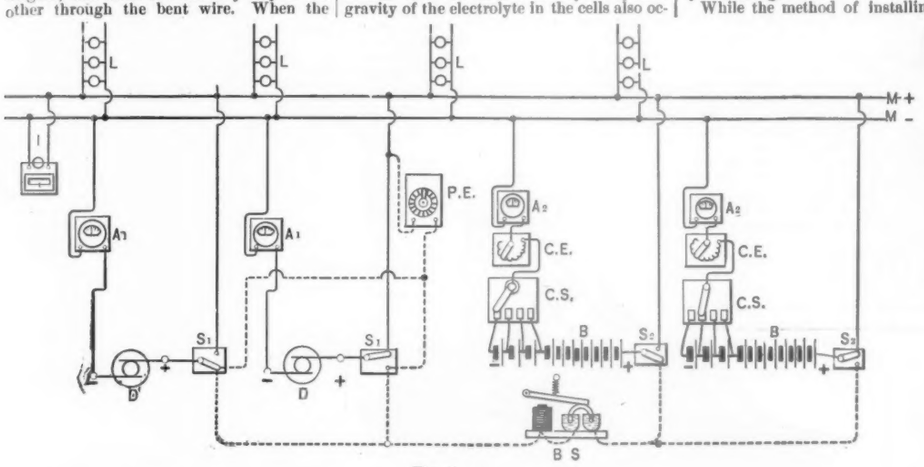

Fig. 6

Fig. 8.

It was mentioned in the early part of this paper that it was possible to injure accumulators either by overdischarging them or working them at too high a rate. It is assumed that, in the larger plants, there will be such supervision available under ordinary working conditions that occurrences of this kind will be avoided; but a simple device for preventing such abuse of the cells in smaller plants, where such supervision is not always convenient, has been devised. It is called an overload and overdischarge switch, and its operation is based on the fact that, when a series of cells is overdischarged, their potential falls below a minimum value, and that when they are worked above their normal rate the current exceeds a maximum value. The apparatus consists essentially of a pressure magnet connected to the terminals of the battery, and of a current magnet in series with the battery; when the potential of the battery falls below a minimum value, the armature of the potential magnet is released and throws an artificial resistance into the battery circuit, and thus reduces the current; and similarly, when the current exceeds a maximum value, the armature of the current magnet is attracted and performs a similar function. The connections of this overload and overdischarge switch, *c* and *p*, are shown diagrammatically in Fig. 7, in which a common resistance, *r*, serves for either magnet. The battery current passes from *a* to *b* through the overload magnet, while the terminals of the overdischarge magnet are, as before stated, in shunt to the battery terminals. In Fig. 8 is illustrated a practical

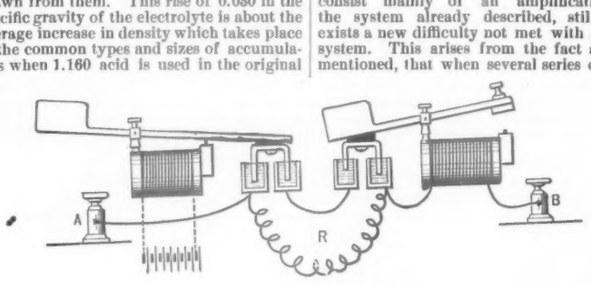

Fig. 7

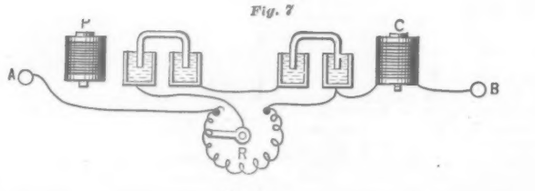

Fig. 9

form of a combined overload and overdischarge switch.

With the object of reducing the cost of the regulating apparatus whenever both the combined overload and overdischarge switch and the current equalizer are to be used with the same series of cells, the switch portion of the equalizer may be mounted on the resistance frame; and thus a single resistance coil be made to do service for both instruments. This combination, of which the connections are shown in Fig. 9, while allowing the current equalizer switch to control the full range of resistance, at the same time causes the whole coil to be thrown into the battery circuit upon the operation of either the overload or overdischarge switch. This, of course, diminishes the brilliancy of the lamps, and thus indicates the state of affairs to those interested.

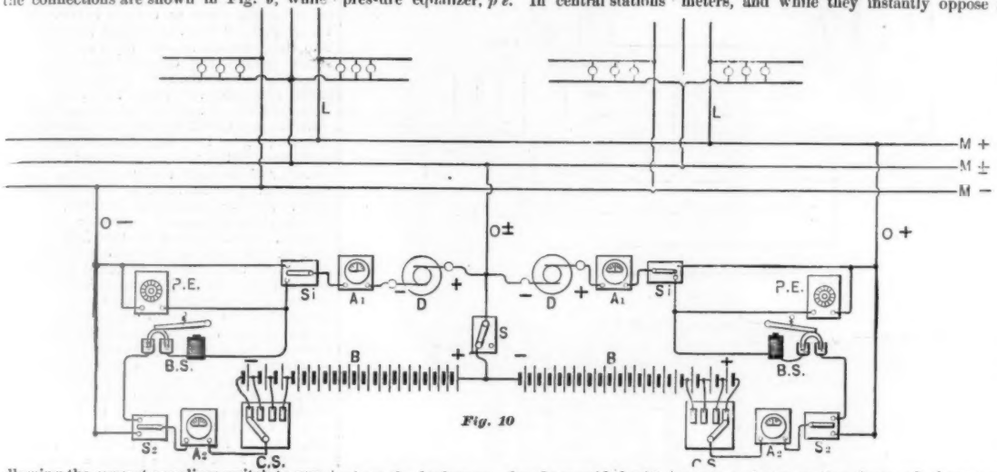

Fig. 10

In applying accumulators to plants operated on the three-wire system, a simple extension of the method already described is adopted, except in the case of small stations requiring only one series of accumulators, and where the working circuits can be multiplied during the light load, so that the ordinary method will suffice. In larger plants the batteries are installed in pairs, each series having the same apparatus as before; and as this has already been fully explained, it will only be necessary to add that, in adapting two series of cells to the three-wire system, the two batteries are connected in series in the same manner that the dynamos are connected. The general plan of this arrangement is shown in Fig. 10, from which unimportant details have been omitted. At the top of this diagram the three horizontal lines m (+), m (±), and m (—) represent the omnibus wires in the dynamo room, from which the feeders, l, are led. The three vertical lines, o (+), o (±), and o (—), are extensions to the omnibus wires to which the dynamos are directly connected in the usual manner when the levers of the switches, s_1, are on their upper contacts. The batteries are also connected with the omnibus wires in a similar way, so that when the switches, s_2, are closed on their lower contacts the batteries will also discharge into the lamp circuits in parallel with the dynamos. Now, if the switches, s_1, are turned to their lower contacts, and the switches, s_2, to their upper contacts, the current from the dynamos will divide at the switches, s_1, part going into the lamp circuits, and part through the batteries, which thus receive a charge. As in the multiple arc system, the potential of the dynamos being assumed to be raised above the normal to meet the requirements of the batteries in order to suitably reduce the pressure on the lamp circuits, it is only necessary to adjust the resistance of the pressure equalizer, $p\,e$. In central stations where the feeders are already provided with pressure equalizers the connections are still more simple, for the batteries are merely connected to the omnibus wires, while all other connections of the ordinary three-wire station are unchanged. In such cases, the increased pressure at which the dynamos are operated during the time the batteries are charging is reduced at the lamps to the proper point by the usual adjustment of the feeder or pressure equalizers. During the charging period all regulation of the accumulators may be dispensed with by opening the switch, s_1, when both batteries will be connected in a single series to the full pressure of both dynamos. In addition to the apparatus shown in the diagram, each series of cells is provided with a double plug switch and sockets suitably disposed, by means of which the relative positions of the batteries on the two sides of the system may be changed by simply transposing the plugs from one socket to the other. The object of this arrangement is to provide means for compensating for the unequal discharge of the batteries when the two sides of the lamp system are unbalanced; and the transposition is never made oftener than once each day. In all other respects the manipulation of accumulators when applied to three-wire systems is practically the same as when they are operated on the multiple arc plan. To increase the accumulator capacity of three-wire stations, double batteries are added in parallel to the first set, just as additional dynamos would be.

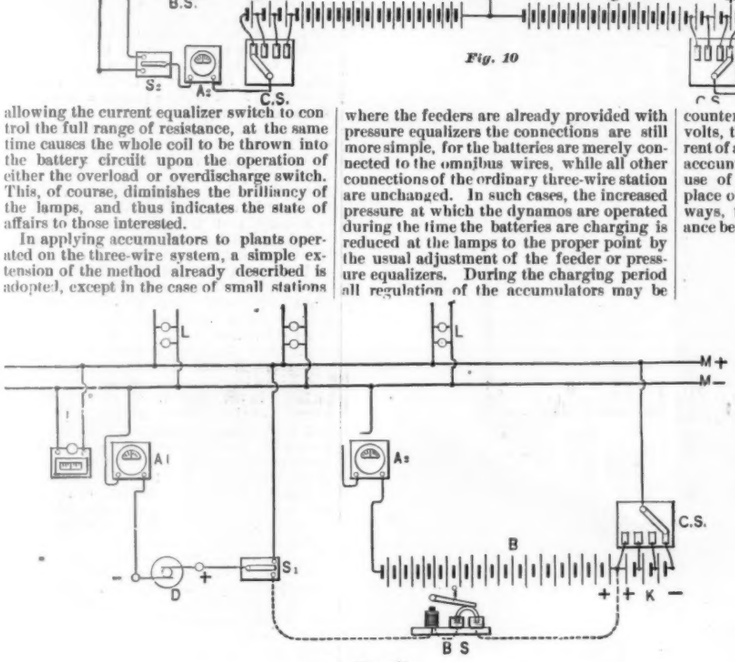

Fig. 11

It was explained further back that the extra or regulating cells in each series often became charged sooner than the remainder of the cells, and required to be removed from the circuit before the others. This operation, of course, calls for some labor; and, little as it is, it would still be desirable to have the number of cells in a series remain fixed both during charge and discharge. By the use of what are called counter electro-motive force cells, this result may be effected, and at the same time the pressure equalizer be dispensed with. These very simple cells are made like an ordinary Planté accumulator of plain sheets of an inoxidizable lead alloy and without active material. When a current is passed through them they act as gas voltameters, and while they instantly oppose a counter electro-motive force of about two volts, they are incapable of producing a current of any appreciable amount or duration on account of their inoxidizable property. The use of counter electro-motive force cells in place of equalizers is advantageous in several ways, for not only may their internal resistance be made so small as to be practically negligible, but their counter electro-motive force is as effectual in reducing excessive pressure as a dead wire resistance, while possessing the unequaled advantage that the fall in potential of the current passing through them is unaffected by any variation in the strength of such current.

The method of using these counter electro-motive force cells is shown in Fig. 11, which represents a single series of accumulators installed in connection with a direct lighting plant operating one dynamo, as first described, and for simplicity and effectiveness this method cannot be well exceeded. The dynamo is connected to the lamp mains, as before, through an ammeter on one side, and through the upper contact of a two-way switch, s, on the other; while the battery, b, is similarly connected to the lamp mains on one side, but on the other the circuit is completed through several counter electro-motive force cells, k_1, the number opposed being governed by the position of the cell regulating switch, $c\,s$. When the lever of switch s is on its lower contact, the charging circuit is completed in the now familiar manner. The action of a plant arranged in the above way is as follows: Assuming the lever of the cell-regulating switch to be turned off, or open, as the expression goes, and that the dynamo switch is on its upper contact, the dynamo alone supplies current to the lamp circuits. If, now, the lever of the cell-regulating switch is turned to its left hand contact plate, the battery will be similarly supplying current to the lamp circuits in conjunction with the dynamo, or alone if the dynamo switch is opened. If the dynamo switch is now turned to its lower contact, the dynamo current will divide at the point where it connects between the battery and counter electro-motive force cells, part going through the battery and back to the dynamo through the (—) lamp main, while the remainder will pass through the counter electro-motive force cells to the lamps. Thus, while the full pressure of the dynamo current will be effective at the battery terminals, its pressure at the lamps will be less by 2, 4, 6, etc., volts, according as 1, 2, 3, etc., counter electro-motive force cells are opposed to the passage of the current into the lamps by the position of the lever of the cell-regulating switch.

When the battery has been fully charged and it is desired to stop the dynamo, the latter may be disconnected by opening the switch, s_1, when the battery alone will maintain the lamps. As previously explained, the potential of the battery will be a maximum immediately after it has received a charge, so that in this case if the battery has the usual allowance of extra cells its potential will be higher than the lamps require. More or less of the counter E. M. F. cells may now be inserted in the lamp circuit, however, until the potential is suitably adjusted. Although during the greater part of the discharge the E. M. F. of the battery will remain fairly constant, if discharged to its limit the potential will slowly fall towards the end, and this fall must be compensated for by removing one or more of the counter E. M. F. cells from the lamp circuit.

It is to be noted that by means of the above method, the number of cells in the battery proper is fixed and unalterable during both the charge and discharge, and that whenever the dynamo is supplying current to the lamps, its surplus current is always available for charging the battery; more over, only one adjustment of the counter E. M. F. regulating cells opposed to the lamp current will be required. It is obvious that counter E. M. F. cells may be substituted with equal effectiveness for the equalizers and regulating cells employed in all the previously described systems, and it seems unnecessary to go into any further particulars in order to illustrate the practicability of such systems when properly installed and operated.

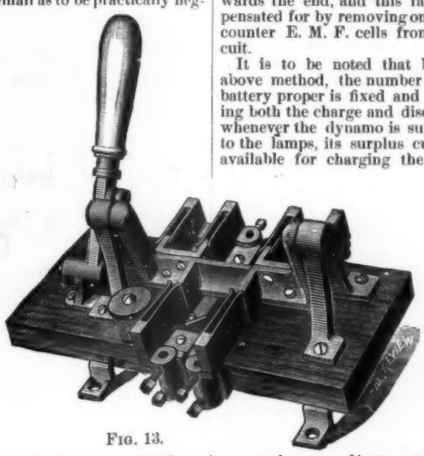
FIG. 13.

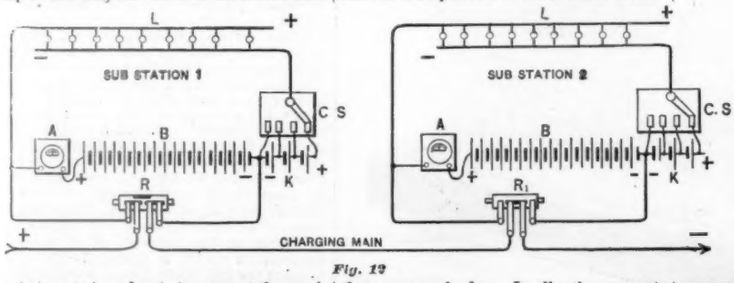

Fig. 12

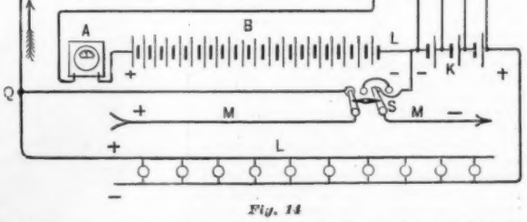

Fig. 14

We have now to consider another branch of the electric lighting business, in which accumulators also claim a share of attention, viz: the supplying of current to lamps located at a considerable distance from the source of power.

The first method to be considered is known as the half direct plan, in which one or more series of cells are installed in any number of sub-stations conveniently located near centers of lamp consumption. The charging station may be situated wherever economy

dictates, without any special reference to the location of the batteries, for although the expense of the charging wire and the cost of the energy wasted in it cannot be neglected, both these factors must be off-set by the saving effected from locating the power station in the most desirable situation. This half direct system is so called because during the period of maximum load half the current is supplied by the charging dynamo, and half by the batteries. At other times the dynamo may be simultaneously charging the batteries and supplying lamps, or the battery alone may be in operation. Each sub-battery station is, in fact, a small central station by itself, and it may contain one or several series of cells, the number, of course, depending upon the amount of lighting to be done in its vicinity. A common charging main, like an arc light circuit, passes through each sub-station, and each battery may be inserted in the main or withdrawn from it at will, exactly as arc lamps are cut in and out of circuit. The charging dynamo is usually of high voltage and of moderate current capacity; machines of 500 volts and 15 amperes to 1,200 volts and 40 amperes may be employed in small stations, while in larger ones the latter machines and their circuits may be multiplied. For charging purposes shunt wound dynamos are preferable on account of their non-reversibility, but even series and compound wound machines may be used if suitable precautions are taken. The arrangement of the accumulators and regulating apparatus in each sub-station on the half direct system is essentially the same as the method adopted in the last described multiple arc system. The connections of two sub-stations installed on this plan are shown in Fig. 12, in which station 1 is shown with its switches in position for both its battery and lamp circuits to receive current from the charging circuit; while station 2 is disconnected from the charging line, which is closed outside of it, and the batteries alone supply the lamp circuits. The switch which is employed to throw the batteries into and out of the charging circuits is of the snap action type, and is sometimes called a consumer's switch. It maintains the integrity of the charging circuit when the batteries are removed from it, and is provided with a spark coil which prevents the opening of the charging line and the consequent formation of the injurious arc which results on the interruption of high potential circuits. A modified practical form of this switch is illustrated in Fig. 13. As shown diagrammatically in the sketch, it consists in the main of four terminal contact springs which bear against an insulated cylinder in which are imbedded two rows of metallic contact strips. In one position the two left hand and the two right hand springs are brought into the electrical contact, but if the cylinder is rotated slightly the two middle springs will be brought into electrical contact, while the two outer ones are left free, as shown respectfully at r and r_1. As before stated, this change is effected rapidly and without breaking the circuits. These switches are usually operated by hand at the beginning and end of a charge, at which time whatever inspection of the cells is necessary is also generally made. By applying the polarized magnet principle to this switch it can be made to operate automatically from the central station through a momentary reversal of the charging current, a principle which has already been applied.

While the method just described of locating the batteries in sub-stations near the lamps to be supplied reduces the resistance of the supply wires to such an extent that the variation of potential with changes in current strength is unimportant compared with what it would be were all the lamps operated from one central point, under ordinary conditions, still a similar variation does occur from a different cause. We have already seen that the potential of a battery is higher while it is being charged than at other times, and that the greater the charging current, the higher the potential of the battery becomes. It is evident that if charging commences when only a very few lamps are burning in a given battery, only a small part of the charging current will be required by the lamps, while the greater part will pass through the battery. This will raise the potential of the battery considerably, and as the lamp mains are permanently connected to its terminals, the lamps will receive an excessive pressure. As the number of lamps increases, however, more of the charging current will pass to them and less through the battery, the potential of which thus becomes gradually reduced until it reaches a minimum, when the number of lamps burning becomes so great that the whole output from both the dynamo and battery is required to maintain them. The variation is in the opposite direction, of course, when the lights are diminishing in number. It is evident from the preceding facts that during the period when the charging dynamo is running and the lamp loads are varying, some regulation of the pressure at the lamp mains at each sub-station is required. This regulation is automatically effected by means of the apparatus shown in Fig. 14, in which a solenoid magnet, a r, and a polarized magnet, p m, are inserted in the battery circuit. In all other respects the relative positions of the battery, lamps and charging circuits remain unaltered from the arrangement shown in the last diagram. The operation of the apparatus in this sub-station will be as follows: Assuming

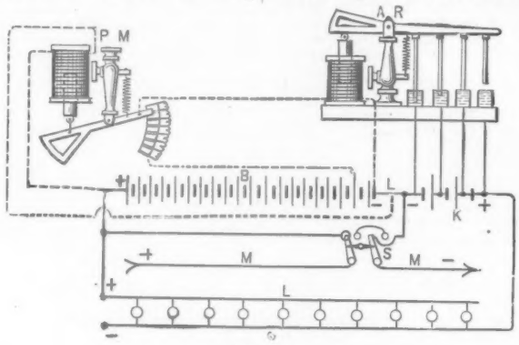

Fig. 13

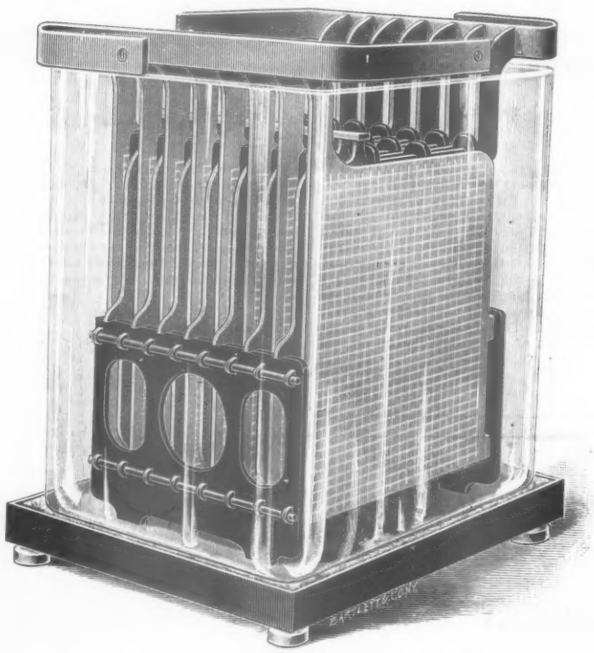

FIG. 16.

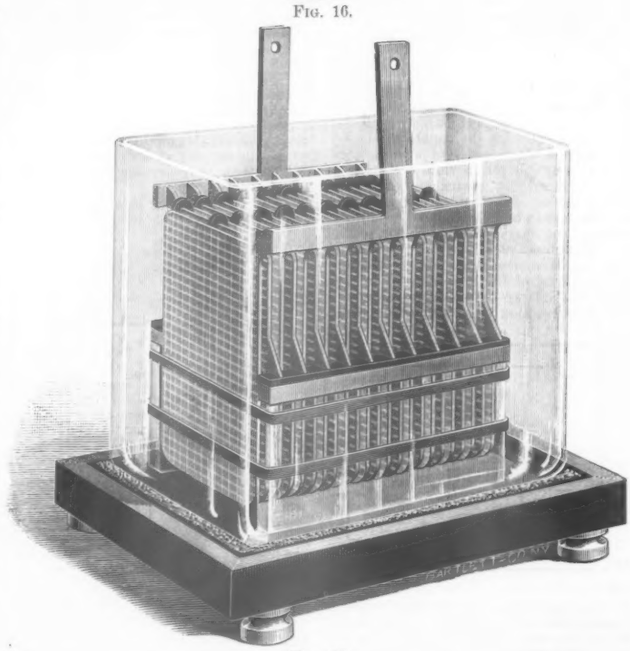

FIG. 17.

the charging dynamo to be delivering a current through the charging main, m, and that the consumer's switch is in the position shown in the diagram, the charging current will pass from m (+) to the point q, where it will divide, part going through the lamps and the opposed counter electro-motive force cells, k, to the point l, and thence to the line again, the remaining part of the current passing from point q through the magnets p m and a r, and out through the battery to point l and line. When the current is flowing in the direction of the arrow, as in the case just cited, the armature of the polarized magnet is moved to its left hand contact, as shown, and the plunger of the solenoid magnet is more or less drawn down, according to the strength of the current. This action of the solenoid magnet causes one or more counter electro-motive force cells to be inserted in the lamp circuit in such a way as to oppose their electro-motive force to that of the charging current, while the full pressure of this current is available at the battery terminals. If now the number of lamps is increased to such an extent that not only all of the charging current passes through them, but also that more or less current from the battery joins in parallel with it; then the current from the battery will traverse the polarized magnet in the opposite direction from that previously taken by the charging current, and its armature will be moved against its right hand contact, thus short circuiting the solenoid magnet and the counter electro-motive force cells, as indicated by the broken line. For, as the sketch shows, the lever of the solenoid magnet is so balanced that when no current is traversing the magnet, its metallic contact rods all dip into their respective mercury cups, and so shunt around the counter electro-motive force cells with which the latter are in electrical connection. When the lamp load becomes reduced and the charging current is discontinued either by the stoppage of the dynamo, or by its being shunted past that particular battery by a movement of the switch, s, to the right, the battery alone works into the lamp circuit, and the counter electro-motive force cells are short circuited.

While the automatic regulator just described, when applied to the half direct system, maintains the pressure at the lamps sufficiently uniform for practical purposes, whether the charging dynamo is operating or not, and although the proximity of the battery to the lamps it supplies prevents undue variation of potential when the load changes; yet a perfectly automatic method of maintaining a constant potential at the lamp circuits, even where the resistance of the leads is great, would be generally useful. Such a method is illustrated in Fig. 15, in which the battery, counter electro-motive force cells, lamps and charging circuits occupy the same relative positions as before. The solenoid magnet of the regulator is no longer in series with the battery, however, and is, in fact, entirely disconnected from it, while the polarized magnet is replaced by a second solenoid magnet, p m, wound to high resistance. The armature lever of this second solenoid is so mounted that when its core is attracted or released this lever moves over a series of contact strips which are insulated from each other. Connected with these contacts strips are coils of wire of suitable resistance, the whole constituting a simple rheostat, more or less of the wire of which is included in a local circuit, according to the position of the lever which acts as a movable contact. The solenoid magnet of the regulator a r and one or two cells of accumulators are also included in the local circuit referred to, the strength of the current flowing in this circuit depending upon the amount of resistance inserted by the movement of the lever of the pressure magnet p m. The latter magnet is connected directly with the battery terminals, and as the potential of the battery rises and falls the current flowing through this magnet varies correspondingly, causing a similar variation in the current in the local circuit. Thus an increase of pressure at the lamps, which are connected to the battery terminals, indirectly causes the armature of the regulating magnet a r to be attracted, and this in turn opposes one or more counter electro-motive force cells in the lamp circuit until the pressure again becomes normal. If the pressure at the lamps falls below normal the regulator acts in the reverse way, cutting out the counter electro-motive force cells until the normal pressure is again restored. If in connection with this method the polarized consumer's switch, previously mentioned, is substituted at s, the operation of such a sub-station will be entirely automatic.

It is proper to mention that the pressure magnet must be very sensitive and requires a delicate adjustment, besides being somewhat costly on account of the excellence of the workmanship required. Although I have only seen the instrument used in an experimental way, its practical application to similar purposes has given satisfactory results.

Under certain circumstances, as, for example, when a lighting station is worked to its full capacity at night but during the day time has ample surplus power, the all-accumulator system may often be applied to increase the capacity of such a station with satisfactory results. In such cases the sub-stations of accumulators are located at distant points in the usual way, the cells being charged during the day and discharged on the lamp circuits at night while the power plant is doing its regular work. The arrangement of the accumulators and regulating apparatus in the sub-stations of the all-accumulator system is practically the same as when the half direct system is employed, except that a simple transfer switch which transfers the battery from the lamp circuit to the charging circuit, and *vice versa*, is used instead of the consumer's switch.

It is needless to say that all of the methods which have been described of employing accumulators in long distance lighting may be adapted to existing lighting plants, and that when so adapted the earning capacity of such stations may be considerably increased without extending the capacity of the power plant. For this purpose there will usually be required a special dynamo at the central

station, a charging circuit taking in the territory outside of the regular lighting limits, and one or more sub-stations with accumulators.

There are, of course, numerous other ways of utilizing accumulators in central station supply systems, such, for example, as the double battery method now operated in England by the Electrical Power Storage Company, in which the dynamos are kept running for 24 hours daily, duplicate sets of accumulators being alternately inserted in the charging and supply circuits at uniform intervals of time, by an automatic mechanical device. But I have limited this paper to a description of some of the simpler methods of accumulator regulation which may be readily adapted to ordinary lighting plants, and, in concluding, can only hope that I have succeeded to some extent, at least, in showing that when so applied in an intelligent manner accumulators do occupy a useful place in the industry of electric lighting.

Through the courtesy of the Electrical Accumulator Company, I am enabled to present to the Institute this evening the first proofs of some cuts of a new line of standard accumulators recently brought out by that company. The cells referred to are shown in Figs. 16 to 21 inclusive, and their dimensions and capacities are described in the following table :—

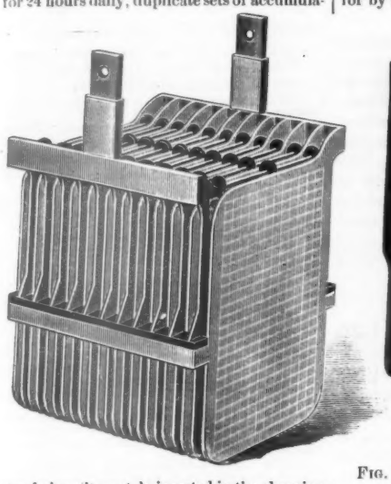

FIG. 18.

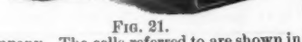

FIG. 21.

LIST OF ELECTRICAL ACCUMULATOR CO.'S STANDARD CELLS.
(Approximate data.)

Figure.	Type of cells.	Charging current. Normal. Amperes.	Working rate and capacity. Amperes. Normal. Rate.	Normal. Ampere hours.	Maximum. Rate.	Maximum. Ampere hours.	External dimensions of jars. Inches. Glass. Length.	Glass. Width.	Glass. Height.	Rubber. Length.	Rubber. Width.	Rubber. Height.	Weight of acid. Lbs. Glass.	Rubber.	Weight complete cell. Lbs. Glass.	Rubber.	Height over all including connections. Inches.
17 & 18	15 L	15 to 80	30	300	40	250	10¾	13¼	13¾	6¾	7¾	9 7-16	50	11	180	40	15¾
16	15 M	15 to 80	15	150	20	170	7¾	9¾	9⅝	4¾	5¾	9 7-16	35	7	130	25	11½
19	15 M	15 to 15	15	100	20	70	7¾	9¾	9⅝	4¾	5¾	9 7-16	35	7	85	25	11½
20	7 M	2 to 6	2	40	3	25	3¾	4¾	9⅝	2⅝	3¾	9 7-16	6	1¼	30	8¾	11½
21	5 S	1 to 2	2	8	3	6	4¾	6¾	9⅝	1⅝	3¾	6 9-16	....	....	18	3½	7

Electro-motive force of each cell is about 2 volts.

—— A new compound 200 horse-power MacIntosh engine has recently been put in by the Somerville (Mass.) Electric Light Company. The company now has three engines of 90 horse-power each and one of 200 horse-power, and it will put in an alternating dynamo of a capacity of 600 incandescent lamps, 270 of which are contracted for by the city.

—— The Holyoke (Mass.) Electric Light Company have placed 600 incandescent electric lights in the weave sheds of the Farr Albaca Company, and they were started last week.

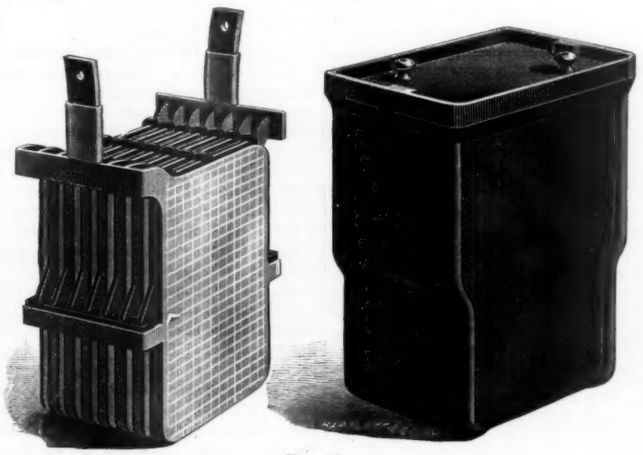

FIG. 19.

—— The new building of the electric light station at Haverhill, Mass., is completed. In it will be placed the new alternating system recently adopted by the company.

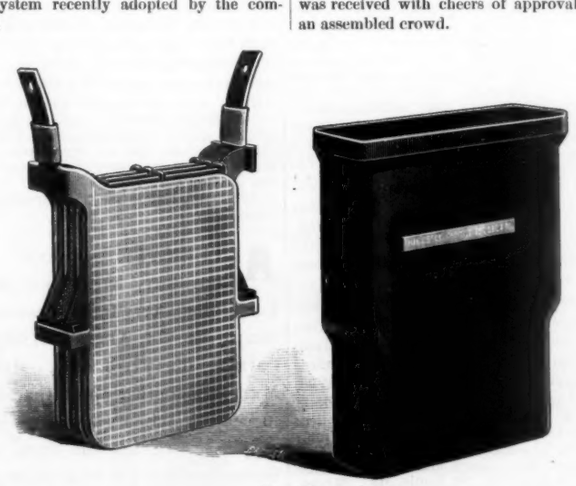

FIG. 20.

—— The United States Electric Light Company, Dubuque, Iowa, which owns the foundation of the oat meal mill, will begin the erection of a brick superstructure next week, and will have an incandescent plant in operation in 60 days. A contract has also been closed for 600 poles.

—— The Fort Wayne Electric Company is pushing its work putting in an electric plant at Michigan City, and the prison will soon possess one of the best and most complete lights in the country. A 10-candle lamp will be placed in each cell, and the prison premises and warden's residence will be perfectly lighted. The work will be completed before the holidays.

—— The Edison Company at Brockton, Mass., it is said, propose to take out all of the 16-candle lights now in use, and hereafter to put in none but 16-candle lights.

—— The Thomson-Houston Electric Light Company, through Hughes F. Gawthrop, manager of the Pittsburgh agency, has just closed a contract to furnish a 70-light arc plant to Carnegie, Phipps & Co. for their Homestead steel works.

—— A dynamo has been placed in position, and the wood and iron shops at the Agricultural College at Lansing, Mich., are already lighted by electricity. Fifty lights are in use, and it is intended to enlarge the plant until all the buildings and the grounds are illuminated by electric lamps.

—— Increasing business of the Rutland (Vt.) Electric Light Company has caused them to put in a new dynamo with a capacity of 50 arc lights, and also a steam condenser.

—— The re-establishment in New Haven, Conn., of an arc lamp which had been ordered removed by the committee on lamps, was received with cheers of approval from an assembled crowd.

—— The board of trustees has refused to grant the Brush Electric Company, of Geneva, N. Y., an extension of the privilege of maintaining its poles and wires in the streets. The present contract runs out in about two years, and the company has already asked an extension of time.

ELECTRIC LIGHT NEWS

—— The trustees of New Rochelle, N. Y., are lighting the streets with incandescent lights instead of arc lights.

—— The Dubuque, Ia., city council has granted charters to four electric light companies and to another street car company.

—— San Luis, Cal., is said to be the smallest city in the United States having a complete electric arc and incandescent light system

—— A dozen of Little Rock's, Ark., most enterprising citizens have perfected a company and purchased the Weggeman electric patents.

—— The business transacted by the Thomson-Houston Electric Company last month is said to have amounted in volume to upward of $900,000.

—— The Fort Scott (Kan.) Electric Light Company is now receiving its machinery for the increase of its plant for lighting the city. The company has put up over 400 additional poles.

—— T. J. Carrothers, of Omaha, Neb., electrician at the electric light power house, has been appointed general manager of the new Council Bluffs Gas and Electric Light Company.

—— A stock company with a capital of $100,000 has been organized in the flourishing city of Fair Haven, Wash., and a plant of 100 electric lights, with extension facilities, will immediately be established.

—— "This city is once again illuminated by electricity," says a Boise City paper. "During the enlargement of the electric light plant it went back to coal oil, simply of necessity; and that the necessity no longer exists causes universal congratulation."

—— A new enterprise is under way at the new plant of the Bangor Electric Light and Power Company at Veazie, Me. Wheel pits are being excavated beside those used for lighting, and a system of waterworks will be put in to supply Brewer, Veazie, Orono and other towns.

—— A recent addition to St. Paul's manufactures is the establishment of the Acme Electric Company, who will remove from their contracted quarters in West St. Paul, where they have been since January, to their new factory building at Upton Grove, 12 or 15 minutes ride from the Union depot on the Wisconsin Central.

—— La Grande, Oregon, has scored another important step in its advancement. An ordinance has been passed by the city council of that place under which the La Grande and Edison Electric Light Company have secured a franchise giving them the exclusive right for 10 years to light the city by electricity. The company will put in 800 lights to start with. The stock of the company is divided into 150 shares of $100 per share, and all shares have been taken and fully paid.

—— The Fisher Electric Company, of Detroit, Mich., has been awarded contracts for wiring for 400 incandescent lights in the new Hammond building on Wilcox street, 300 incandescent lights in the Detroit College of Medicine, 400 incandescent lights in the new Police Court building, 150 electric bells and 5,000 feet of speaking tubes in Harper Hospital, 100 incandescent lights and burglar alarm in G. Hart's new residence on Jefferson avenue, 100 incandescent lights in W. A. Avery's new residence on Woodward avenue, and many others.

—— The Electric Light Company, of Somerville, Mass., has decided to put in an alternating dynamo to run the 270 small lamps that are to be sandwiched in in the dark places of the city. The poles are now being erected and in a short time the six circuits for incandescent lamps, employing about 1,000 volts for each circuit, will be in operation. The dynamo will have a capacity of over 600 lamps, so that there will be upwards of 300 that can be used for commercial or domestic lighting after the streets have been provided for.

* * A franchise for a street railroad and electric power works has been granted in Ukiah, Cal.

* * The people of Memphis, Tenn., are petitioning the city fathers for an electric street railway.

* * The Fulton County (Georgia) street railroad using electricity, Thomson-Houston system, has three miles in operation, and will start about eight miles more this week.

* * The Ashland (Ky.) city council has granted the Ashland and Catlettsburg Electric Street Railway Company the right of way through that city. The line will be completed within the year.

* * The Naumkeag street railway, of Salem, Mass., will increase its capital stock to $200,000, which will be used in equipping its road with the electric system. The road has been using the electric system, and finds it very efficient and also economical.

* * The Western Atlanta (Ga.) street railroad, Daft system, has begun the construction of about 10 miles of street railroad. The city council of Atlanta has granted five other horse car lines, already constructed, permission to use overhead electric systems.

* * It is now announced that the new Beverly (Mass.) and Danvers storage battery road will be formerly opened to the public next week. It is probable that the road will be leased to the Union Electric Company, who will operate it on percentage for the company.

* * The Common Council, of Milwaukee, Wis., passed an ordinance granting a franchise to build an electric street railway, to the Northwest Electric Construction and Supply Company, Minneapolis, Western agents for the Thomson-Houston Company. Work will begin next spring.

* * D. E. Johnson, Atlanta, Ga., has about completed a new motor for street cars to be operated by storage battery. A car has been fitted up and storage battery secured, and it is expected that the car will be running regularly on one of the lines within 15 days. The motor is novel in many features.

* * The application of the Utica (N. Y.) and Mohawk Street Railroad Company for permission to operate its system of railroads by electricity, has been favorably considered and a resolution granting the application in full granted. The franchise is the same and given on the same conditions as that granted to the Belt Line Company.

* * Electric railway agents have been in Greenfield, Mass., securing signatures to a petition which will be presented to the next legislature, asking for a charter for an electric railway between Turners Falls and Greenfield. It is said the road can be built for $5,000 a mile, and that a capital of $35,000 would be all that is required.

* * At a meeting of the stockholders of the Eckington Electric Street Railway Company recently held at Washington, D. C., the following directors were elected: A. T. Britton, C. C. Duncanson, E. Kurtz Johnson, Jos. Paul, John Ridout, L. M. Saunders, T. Somerville, George Truesdell and B. H. Warner. The secretary's report shows $3,346 over expenses.

* * Ordinances authorizing the establishment of electric motor systems on street car routes 18 and 13, running to Cumminsville and Avondale, Ohio, respectively, has been approved by the mayor of Cincinnati, Ohio. He also has approved the ordinance prescribing the manner in which electric light companies may erect poles and string wires, a measure which has hung in the council nearly three years.

* * The Common Council at Green Bay, Ill., has granted a franchise to the Northern Electric Construction Company to build an electric railway, work to begin in the spring.

* * The Genesee and Water Street Railway Company, Syracuse, N. Y., presented a petition to the common council asking permission to extend the company's tracks through certain streets, and to use electricity as a motive power on its line. Agents of the company have been at work securing consent of the property owners along the line of the proposed extension, and no opposition has been met with.

* * The Pittsburgh (Pa.), Knoxville and St. Clair electric street railway will be re-opened for traffic inside of two weeks. Five new motors are completed, and cars will be run every 12 minutes. Several thousands of dollars have been expended in repairing the road. The underground conduit on South Thirteenth street has been replaced by an overhead system of wires. The road has been out of operation for about five months.

* * The new Western Atlanta, Georgia, electric street railroad, the franchise for which has been granted by the city council, will doubtless prove of value to the citizens living on the outskirts of the city. The contract has been signed with the Daft Motor Company to equip the line, and the latest electric improvements will be made use of. Mr. U. B. Mills has been elected president of the company, and the capital for the construction has been paid in.

* * Prospects are bright for the Denver (Col.) and Fort Logan railway, which is the title of the electric road to run across the Platte through the southwestern district. The amount actually pledged in writing is $60,000 in six blocks, $10,000 each, and there is an additional sum of $40,000 assured from four other parties. The line will be nine miles in length, and will cost, in running order, about $180,000. The present intention is to have the line completed this year if possible.

* * A new electrical device has just been put on two of the electric cars of the Cambridge (Mass.) line for experiment. It is called an electric light coupler and is intended for use when a second car is attached to the power car. By snapping the coupler together at the ends of the connected cars electric light is provided for the rear car, thus doing away with the use of oil. This coupler practically solves the problem which the West End railway has been working over in the endeavor to provide some means for lighting attached cars with ease and safety.

* * The paper mills of the L. L. Brown Company at Adams, Mass., will probably be run by electricity in a short time. They are now investigating a scheme for applying electricity in driving the machinery. A mile above Adams there is a 30-foot fall in the river and the company propose to put up an electrical plant to be run by the water power thus obtained, the electricity being carried by wires to the mill. The engine now used is of 200 horse-power, and if sufficient water-power can be obtained to run a dynamo strong enough to drive the machinery, the project will be carried through.

* * Among the latest electric railway contracts of the Thomson-Houston Electric Co., are the following: Albany City Railway, Albany, N. Y., 32 cars and 14 miles; City Electric Railway, Nashville, Tenn., 6 cars and 3.61 miles; Kearney Street Railway Co., Kearney, Neb., 2 cars and 8 miles; Macon City and Suburban Railway, Macon, Ga., 4 cars and 4 miles; Metropolitan Street Railway, Toronto, Canada, 2 cars and 3 miles; Milwaukee Cable Co., of Milwaukee, Wis., 12 cars and 5 miles; Minneapolis Street Railway Co., Minneapolis, 10 cars and 8 miles; St. Paul City Railway Co., St. Paul, Minn., 20 cars, 51 miles; St. Louis Bridge Co., St. Louis, Mo., 4 cars and 2 miles; Union Depot Railway Co., St. Louis, Mo., 20 cars, 10 miles. A contract has also been received for 20 cars from the St. Paul and Minneapolis (Minn.) Railway Co., which will construct a 20 mile interurban road between both cities. The West End Railroad has 50 motor cars in operation at present and 35 miles of track in use for the electric cars. All the Sprague and Bentley-Knight motors have been withdrawn from the road, leaving only those of the Thomson-Houston system.

Stillwell & Bierce Manufacturing Company.—This well-known Dayton, Ohio, company has received the high endorsement of a gold medal for its Victor turbine exhibited at the Paris Exposition. In addition to its large business in this country, the Stillwell & Bierce Company finds the foreign sales of the Victor rapidly extending, and has every reason to feel satisfied with the present outlook.

The Pond Engineering Company are making some large shipments to Texas. A complete 125 horse power-steam plant for an electric railway in Laredo, and a 70 horse-power outfit for the State capitol building, Austin, together with a couple of car loads of fire brick, went forward last week. Their Kansas City office closed a contract with the Northeast Electric Railway for two Armington & Sims engines of 150 and 70 horse-power respectively, with the necessary pumps, heaters, etc., to make the steam plant complete.

A Novel Electric Railroad.

A novel electric railroad is now in operation in England, which is very different from any road now running in this country. About a foot and a half from the car on the side of the track a flat rail runs; this rail being raised on posts of a foot in height, the current travelling on this rail ceasing abrupt on one side of the road, and the car propelled by its momentum plying across the road where the rod catches on to the rail once more. The ends of the raised rails are connected by a wire passing under the road. The cars often travel at the rate of 20 miles per hour. The generator is operated by water power.

Fire in an Electric Light Station.

On the morning of October 24th the large building owned and occupied by the Thomson-Houston Electric Light and Power Company, at Atlanta, Ga., was badly damaged by fire, the roof and second story being entirely destroyed. The building contained 1,000 horse-power boilers, six engines and and about 20 large dynamos. The fire began at 3.30 A. M. in one of the cupolas. When Fire Chief Joyner arrived he covered all the dynamos and engines with heavy oil cloth covers, which the department always carry, and then began work on the fire which had secured terrific headway. At 5.30 A. M. the fire was out, and H. E. W. Palmer, president, and Geo. H. Wade, superintendent of the Georgia Electric Light Company (the local name), took charge of the building, and put a large force of carpenters, laborers and linemen to work. Through the efforts of Superintendent Wade, at 6.45 A. M. the power dynamo which runs the Edgewood street car line was started, and has been going ever since. At 2.30 P. M. the city power circuit, which supplies many factories and printing offices was started, and at 5.30 P. M. the arc and incandescent lights shone forth brilliantly over the entire city. This was remarkably quick and intelligent work. All the wires, between 40 and 50, leading out of the plant had been cut loose and were lying around in ropes and knots. This plant furnishes about 300 arc lights and several thousand incandescents. The second story has a temporary cover to protect the machinery from rain while the carpenters are rebuilding.

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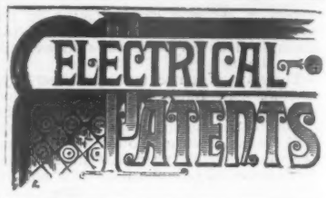

INDEX OF INVENTIONS FOR WHICH LETTERS PATENTS OF THE UNITED STATES WERE ISSUED ON OCTOBER 30, 1889.

413,707 Metallic circuit; Henry F. Campbell, Malden, Mass.

413,708 Electric safety lamp for miners; Theophilus Coad, Forrest Gate, County of Essex, England.

413,731 Conduit for electric railways; Cecil P. Poole, Lynchburg, Va.

413,782 Telephone diaphragm; Alexander W. Hall, New York, N. Y.

413,795 Anti-induction system; John O. Stockwell, Burlington, Kan., and Albert Barrett, Kansas City, Mo.

413,810 Transformer or converter for alternating electric currents; Leonard Paget, New York, N. Y., assignor of one-half to Charles J. Kinter, same place.

413,813 Combined binding post and thermal cut-out; Howard C. Root, Brooklyn, N. Y., assignor one-half to John C. Reilly, same place.

413,848 Telegraph key; Eugene S. Crull, Mount Carmel, Ill.

413,879 Electric train signal; William Winder, Portsmouth, N. H.

414,025 Electric stop motion for twisting machines, etc.; Victor I. Clennock, Lowell, Mass.

414,043 Electric regulator; Ludwig Gutman, Fort Wayne, Ind.

414,049 414,050 Electric railway; Rudolph M. Hunter, Philadelphia, Pa., assignor by mesne assignments to Thomson-Houston Electric Company, Boston, Mass.

414,052 Method of regulating electric motors; Moritz Immisch, London, County of Middlesex, England.

414,076 Electric current indicator; Gustav Pfaunkuche, Cleveland, Ohio.

414,085 Electric mechanism for operating telephone call bells; Frederick W. A. Schneider, Toronto, Canada.

414,130 Arc lamp; Friedrich W. R. Seifert, Atona, assignor to Otto Lindemann, Hamburg, Germany.

414,132 Telephone supporting device; Samuel J. Adams, assignor of three-fourths to Jacob Brown and Arthur Brown, same place.

414,141 Arc lamp; Frederic G. Chapman and Fred. M. Dearing, London, England, assignors of one-third to William George Chapman, same place.

414,155 Electric fire signal; Charles B. Head, Allegheny, Pa.

414,172 Electric railway; Frank J. Sprague and Patrick F. O'Shaughnessy, New York, N. Y., assignors to the Sprague Electric Motor and Railway Company, same place.

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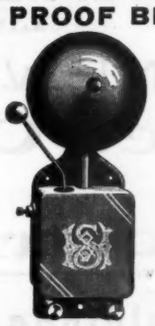

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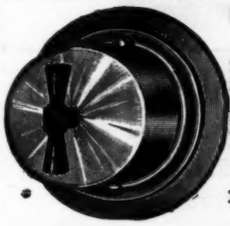

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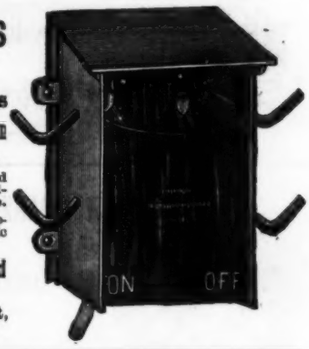

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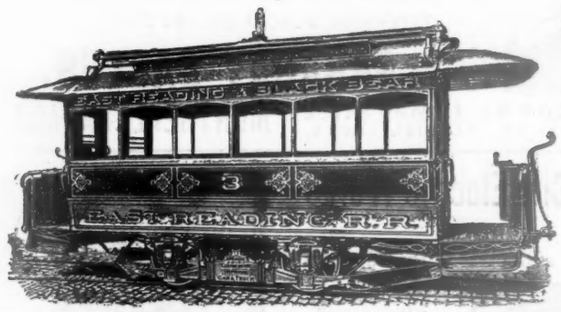

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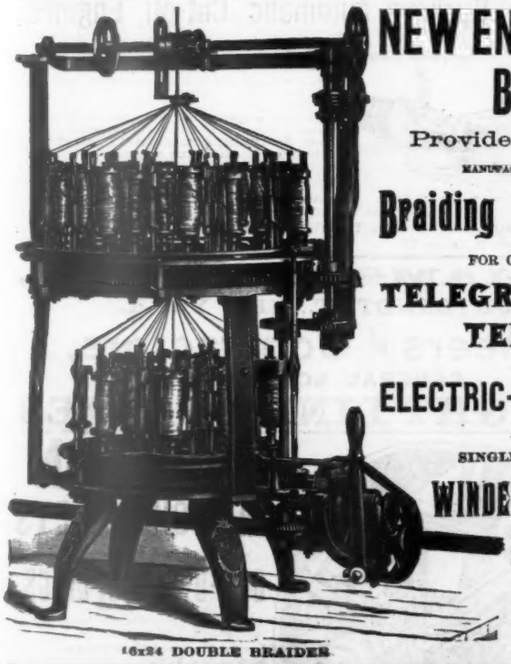

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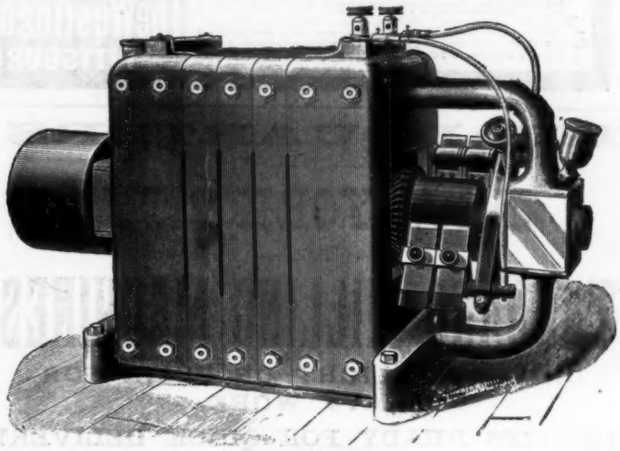

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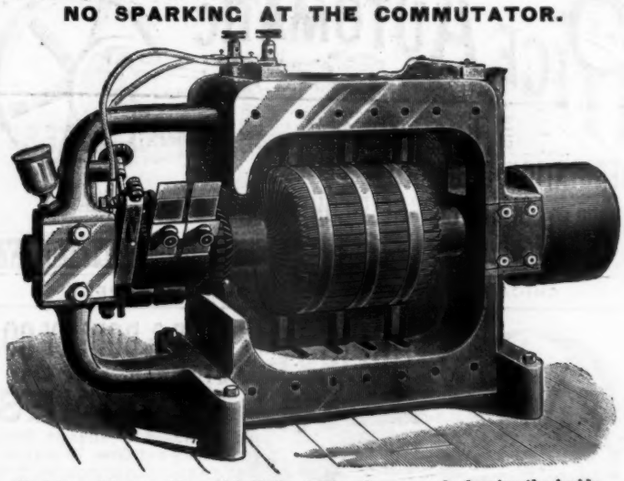

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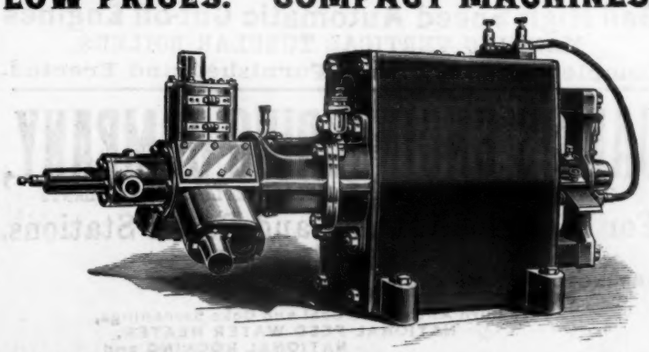

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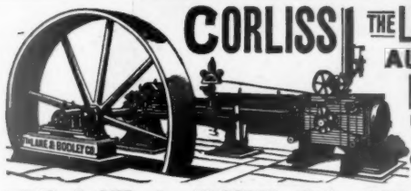

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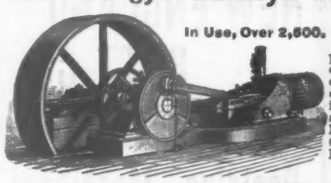

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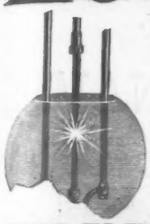

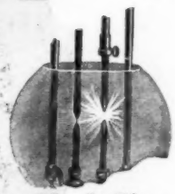

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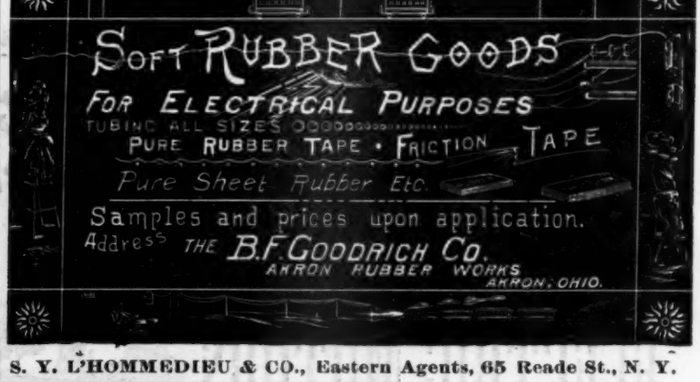

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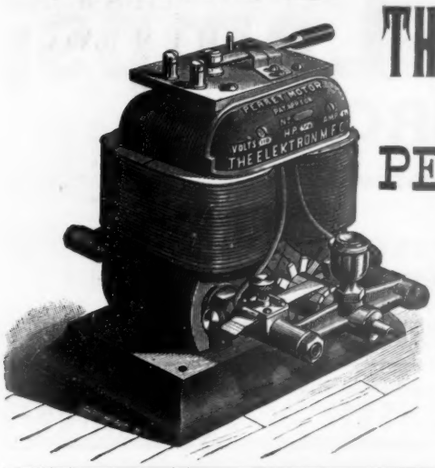

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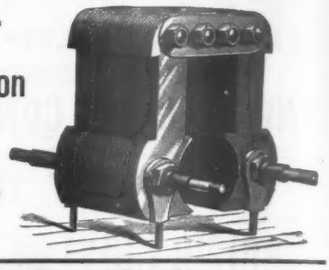

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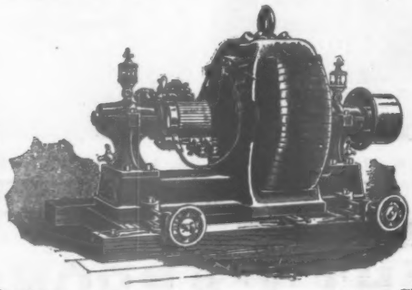

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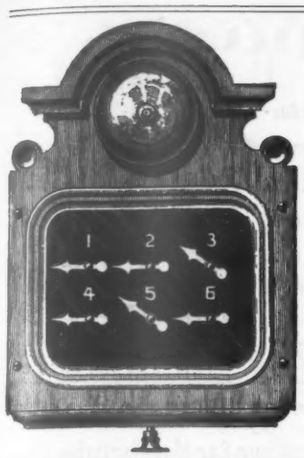

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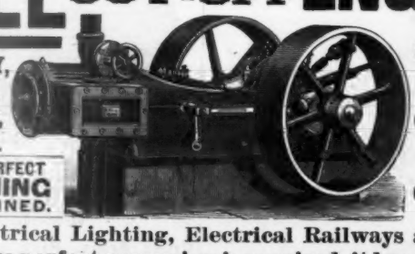

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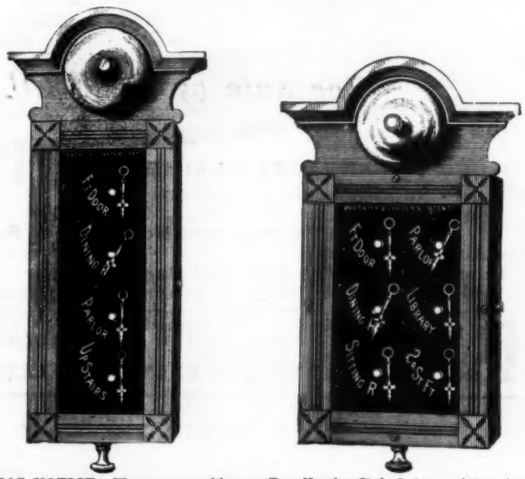

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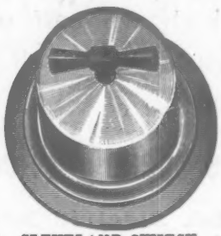
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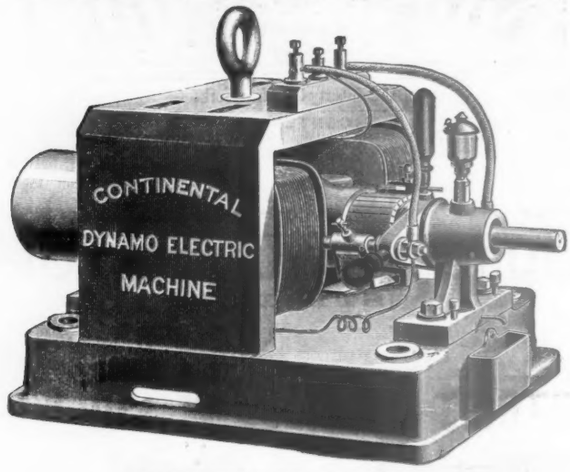

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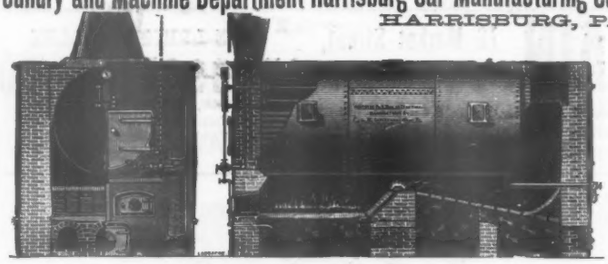

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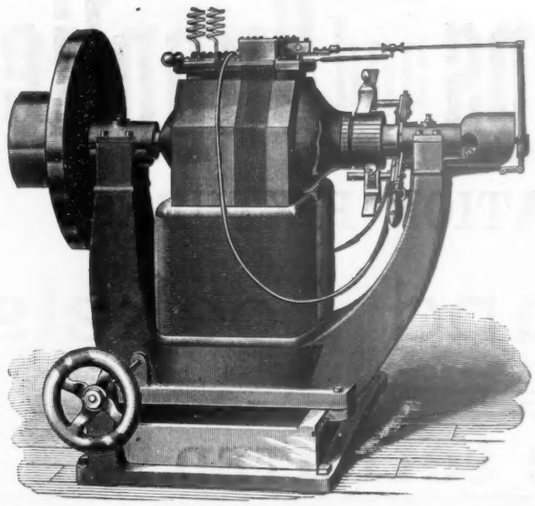

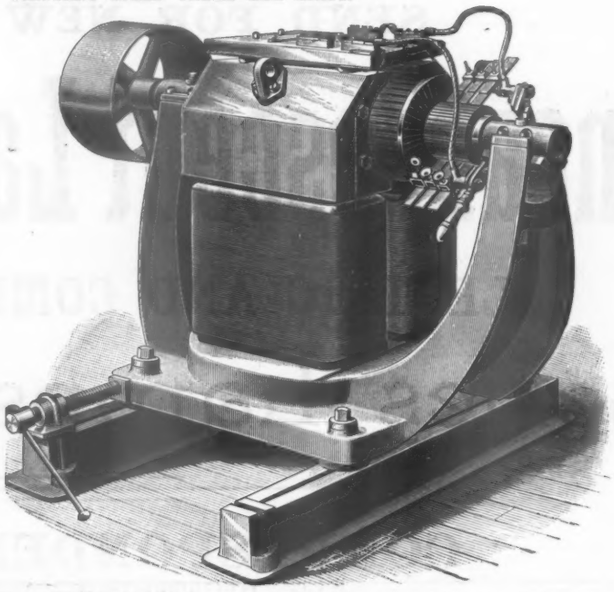

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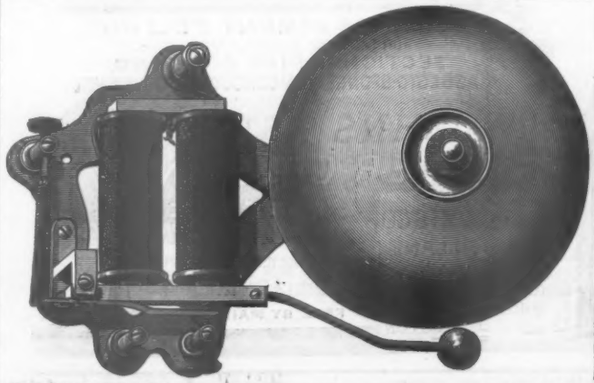

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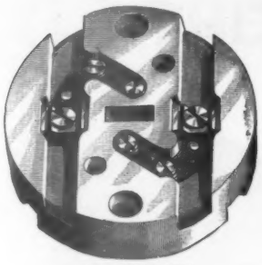

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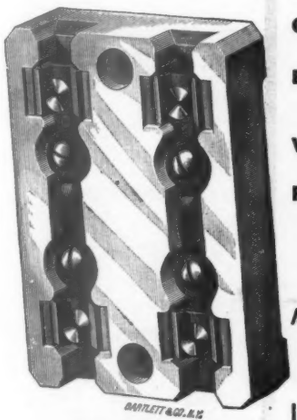

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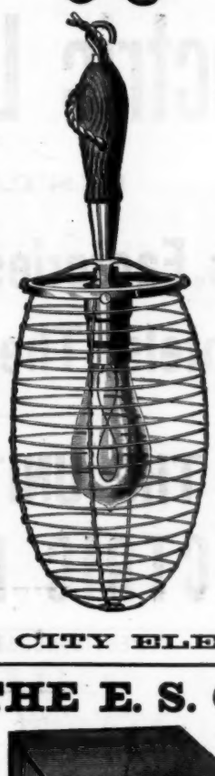

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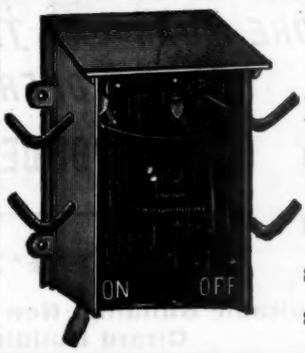

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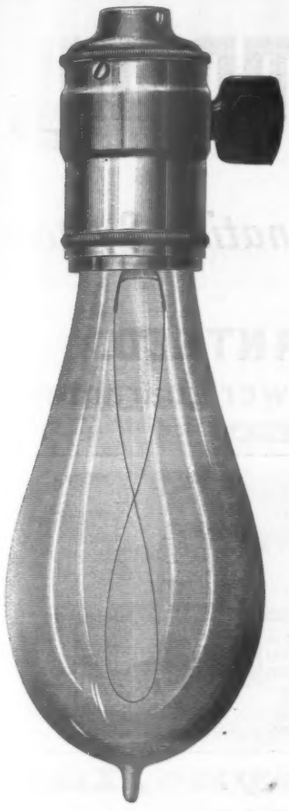

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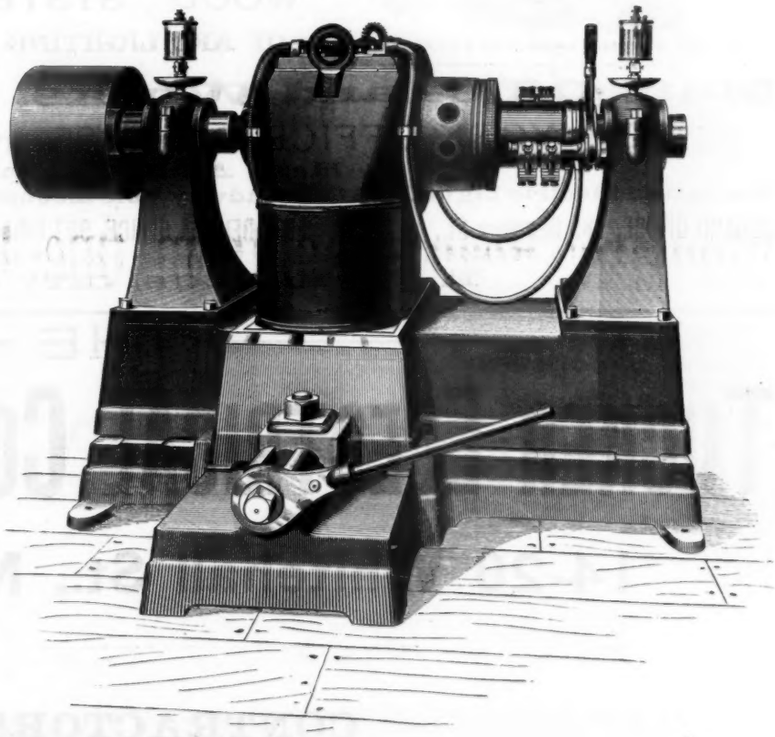

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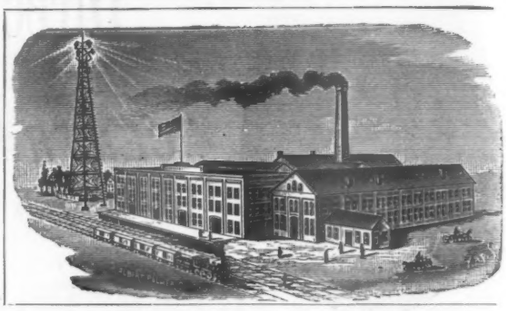

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